



**Time to Set Aside Caps that Don't Fit: The Limits of Spectrum Policy in
Canada**

Leonard Waverman, Dean, Haskayne School of Business, University of Calgary.

AND

Kalyan Dasgupta, Principal, Berkeley Research Group, LLC.

February 26th, 2011



Contents

1. INTRODUCTION	1
2. APPROPRIATE GOALS FOR SPECTRUM POLICY	7
3. “INSUFFICIENT” COMPETITION?.....	10
4. “NATURAL LIMITS”: INTERNATIONAL EVIDENCE.....	14
5. AUCTIONS, SPECTRUM ALLOCATION AND PROMOTING COMPETITION.....	17
5.1. The Theory of Pre-emption	18
5.2. Should we expect to see pre-emption premiums in wireless?	22
5.3. Entrants do acquire spectrum without set asides	24
6. COSTS AND BENEFITS OF “SPONSORED ENTRY”	26
6.1. Set-asides raise incumbent spectrum costs	26
6.2. Unviable entry and resource waste	27
6.3. A continuing cost of set-asides in Canada	28
6.4. Social costs of entry	28
6.5. Spectrum caps	30
7. MARKET DEFINITION: WHO IS AN ENTRANT AND WHO IS AN INCUMBENT?.....	34
8. SOME BRIEF CONCLUDING THOUGHTS	37



1. INTRODUCTION

1. The following report, commissioned by Bell Canada, contains comments on some key aspects of spectrum policy¹. The report has been prepared to inform Industry Canada's thinking as it devises a policy framework for the auction of 700 MHz spectrum in Canada.²
2. Spectrum policy is a large and complex area, and in this report, we only provide a brief overview of the general considerations that ought to inform any spectrum allocation policy. We then proceed to offer comments on specific issues that ought to be considered as part of the policy framework for the 700 MHz auction.
3. The specific issues that we comment on are:
 - Whether and under what circumstances auctions should depart from the general rule that the highest bidder is the most efficient user of spectrum;
 - The specific merits of spectrum set-asides and spectrum caps in Canada;
 - Specific aspects of the “pro-entry” spectrum policy applied by Industry Canada in the 2008 auction;
 - The feasibility and merits (if any) of different policy instruments to increase or promote competition in the Canadian wireless market.
4. To summarise our basic thesis, we believe that spectrum policy is an unnecessary, risky, and socially costly tool by which to attempt to increase competition in the Canadian wireless market.
5. The policy question that Industry Canada faces regarding the 700 MHz auction is not so much one of promoting new entry, but one of *sustaining* the recent entry into the industry. That recent entry occurred in the context of a set-aside of AWS spectrum for new entrants in 2008. Thus the question posed by Industry Canada in their consultation document is whether there is a need to parallel the measures that were taken in 2008, or even go beyond them, in order to *sustain* entry.
6. The presumed logic of the argument that suggests the use of spectrum policy to subsidize entry using set asides or other means is as follows:
 - First, the performance of the Canadian wireless market is not good, particularly in relation to other countries;

¹ The views expressed in the report are those of the authors, not of Bell Canada or of Berkeley Research Group. Responsibility for errors and omissions rests with the authors.

² Industry Canada, SMSE-018-10, *Consultation on a Policy and Technical Framework for the 700 MHz Band and Aspects Related to Commercial Mobile Spectrum, November 30th, 2010* (“**Industry Canada Consultation Document**”).



- Second, the reason for Canada’s poor performance is insufficient competition in the Canadian wireless market;
 - Third, more entry is the solution to this problem of insufficient competition, but spectrum could be a barrier to entry. Acquiring spectrum may be difficult for new entrants because incumbent wireless firms have an incentive to outbid entrants for spectrum, in order to preserve their market power and prevent an increase in competition. The incentive for incumbents to outbid entrants reflects a premium over the value in use of the spectrum. The existence of this premium means that the general rule that all spectrum should be awarded to the highest bidder should not be followed. Instead some spectrum should be provided to entrants to facilitate entry and competition;
 - Fourth, facilitating entry results in entry that is viable (that is, the entering firms can sustain their presence in the market, which would imply that they are profitable in at least the long-term); and
 - Fifth, the subsidized entry is efficiency enhancing and improves the welfare of Canadian users of wireless services.
7. We show that that all of these factors likely did not apply to the 2008 AWS auction and are even less applicable to the 700 MHz auction. Set asides, or other measures, in the 700 MHz auction should not be used to subsidize the sustainability of the AWS entrants. New entrants have perhaps 2% of the overall market, and their spectrum holdings (e.g., the 40 MHz held by Videotron) are very comfortable relative to the actual traffic volumes supported on their network.
 8. The critical factor determining these firms’ ability to sustain their entry is not spectrum, but instead is their ability to finance network expansion, to develop brands, to forge supplier relationships and customer relationships. Adding more spectrum does little to alter their chances of success, but it instead raises the opportunity costs associated with depriving proven and established operators of necessary spectrum (That is, another set-aside policy makes it even less likely that their entry is efficient and beneficial to Canadian consumers of wireless service).
 9. We begin by showing that Canada’s wireless performance is not lagging, at least not when a wider and more robust set of indicators are used to assess performance. In any case, Canada’s wireless market is less concentrated than the markets of many other nations that are judged by some to be better performers.
 10. Second, the starting point of any analysis is to recognize that competition is not an end in itself, but a means to other ends. The ends are the policy objectives of Industry Canada: an efficient wireless sector that serves the interests of Canadian residential and business users of wireless services. In an industry such as wireless communications characterized by significant economies of scale, scope, and sunk costs, simply increasing the number of competing firms *is* unlikely to achieve the policy objectives of Industry Canada. In this report we explain why the five conditions outlined above are unlikely to hold and, in fact, that set-asides and spectrum caps intended to increase the number of wireless networks



are likely counter-productive. Instead of increasing the welfare of Canadian wireless users, they may well do the exact opposite.

11. Wireless telecommunications firms cannot price at short run marginal cost as firms in textbook “perfectly competitive” markets would. Instead they must price at levels in excess of short-run marginal cost, in order to pay back the large sunk investments that are involved with deploying networks. On a comparison of price to short-run marginal costs, such firms might appear to be enjoying “market power.” However, this is a mistaken inference as the firms are earning “quasi-rents”³ so that they recover the fixed and sunk costs associated with operating in the industry.
12. The high set-up costs associated with network deployment then places intrinsic or “natural” limits on the amount of entry that the wireless industry is capable of sustaining. This limit is determined by the interaction of scale and scope economies with market demand such that the so-called “quasi-rents” of firms just cover sunk costs. Incumbent firms must be of sufficient size in order to realize gross margins sufficient to break even. If the number of firms is below this natural limit, then that is an indication that there is insufficient competition. On the other hand, attempts to increase the number of firms beyond this natural limit will be unsuccessful. The increase in competition will depress margins and market share below the level required to break even, resulting in consolidation or exit from the market.
13. The existence of a natural limit dictated by the interaction between set-up costs and available demand seems to be borne out by the fact that most markets around the world have three to four national wireless competitors. Further, the number of competitors does not increase much with population size: Sweden with 9 million people has four competitors as does Germany with over 80 million. In many countries, three competitors have more than 90% of the subscribers in the market, and the two leading firms quite often have more than 75%, implying that the existence of fourth and even third competitors is somewhat insecure. Consequently, the likelihood of “successful” entry in a mature market with three or more sizeable existing competitors is debatable, and this would be the case even if spectrum were free.⁴
14. With three national networks and two regional networks even prior to the AWS auction, the number of Canadian networks is near this natural limit. This suggests that insufficient competition is not an issue and that the high short-run margins and market shares in the wireless industry in Canada—similar to wireless sectors in other countries—is not consistent with the inefficient exercise of market power. There is likely not a competition problem to be fixed by allocating spectrum on a preferential basis to the AWS entrants to sustain competition.

³ This term essentially refers to margins above short-run marginal cost.

⁴ There is some variation by density zone within countries that do not license on a national basis, e.g., one can expect to see one or two more facilities-based wireless operators in the metropolitan regions of major cities such as New York, Toronto, etc than the norm, and conversely one might see fewer operators in lower-density zones.

15. Third, we consider the circumstances under which incumbents have an incentive to pay a premium above use value to deter entry or expansion of the AWS entrants. We find that under certain circumstances incumbents have incentives to pay a “pre-emption premium” to outbid entrants for spectrum that would enable their entry or expansion. Of more relevance to the current situation in the Canadian wireless sector, the economics of pre-emption also suggest circumstances where incumbents would *not* have an incentive to bid a premium (and thus shut out entrants and smaller firms) in order to preserve their market power. These circumstances are: when it is uncertain the entrant or smaller firm is successful after acquiring spectrum; the competitive threat to the profits of any incumbent from entry is limited; the time it takes for entry or expansion is significant; there are multiple incumbents; spectrum is not in perfectly inelastic supply (there are multiple licences and multiple auctions), and entrants are more optimistic than incumbents regarding the profitability of spectrum.
16. We explain why these circumstances are pertinent in Canada today. In particular, there is substantial uncertainty about whether entrants will actually be able to threaten incumbent profits and about whether and when the purchase of spectrum will translate into actual network deployments. The presence of multiple incumbents mean that each incumbent has incentives to rely upon the investments made in deterring entry by other incumbent firms, and thus lead to no firm successfully deterring entry (in the language of economics, this is a classic “free rider” problem). Finally, the high costs of deterring entry when there are multiple entrants and multiple licenses also support the conclusion that incumbents will not pay a premium for spectrum based on preserving their market power. This theoretical assessment that incumbents will not pre-empt spectrum is supported by the actual evidence from other countries, that entrants have been successful in acquiring spectrum at auctions without being given preferential access.
17. Fourth, the fact that the wireless sector in Canada is at or near the natural limit suggests that further entry is unlikely to be viable. Instead subsidized entry will only create an increase in competition in the short run. In the long run, margins will have to rise and the natural limit will be restored as firms exit or there is consolidation. Unfortunately the price in the long run might rise if the set aside results in higher average costs for the incumbents—which it easily could if the set aside means that they have to inefficiently substitute capital or lower quality spectrum for spectrum in the 700 MHz block.⁵
18. Fifth, the additional entry from subsidization is unlikely to be efficient. To understand why we must distinguish between “private benefits” that accrue to the entrant or expanding smaller firm(s), and the “social benefits” that accrue to society as a whole. For example, a transfer of customers, revenues and profits from incumbent firms to competitors is a private benefit to the entering firm, but it is not a social benefit. If the

⁵ In addition, a set-aside could severely limit the supply of spectrum for incumbent firms, thus raising their spectrum acquisition costs and impacting their financial standing. While some purist economists would insist on arguing that spectrum acquisition costs do not impact subsequent pricing and investment decisions, the financial impact that debt incurred to finance spectrum purchases may constrain firms’ investment ability.

entry or subsidized expansion creates value by expanding output and product variety, then this expansion creates social value. There are, however, circumstances in which the subsidised entrant/expansion might be profitable in the sense that it diverts revenue and profits away from incumbent firms, but the net benefits to society are still negative. This is because facilitating this entry requires a duplication of network costs and increases average costs across the industry.⁶

19. The problem with set-asides in this context is that they are especially prone to promoting entry by firms that have relatively high costs or relatively similar products to the incumbents. This is because in the realistic case when a pre-emption premium by incumbents is not a concern, the firms whose entry is contingent upon the set-aside are those firms whose “use value” for the spectrum is below that of other firms. In other words, such firms expect to derive less from using that spectrum than other firms, which cannot be true for entrants that are efficient and add social value.
20. The increase in subsidized competition *might* create short-term benefits for consumers in the form of lower prices, particularly in certain market segments. However, there is a high probability that deep discounting strategies used by entering firms to attract customers will not be sustainable in the longer term. One must also remember that by reducing the economies of scale available to existing market players, entry might raise the costs of these existing players, and thus result in *higher* prices. Further, incumbent firms that find their margins under pressure from entry might respond by consolidating their operations. In this case, the previous market structure is eventually restored and the entry merely results in a replacement of existing firms by a new firm. Such mere replacement should not be confused with an increase in competition.
21. There is another consideration relevant to implementing a set-aside in the Canadian wireless market. In the 2008 AWS auction, incumbent firms were unable to each win 20 MHz of spectrum in key provinces, a factor that could constrain their deployment choices going forward. If Industry Canada uses another set-aside that has similar consequences in constraining incumbent firms’ choices, then it is picking what firms can and cannot do. It is achieving a situation in which the options of viable and proven firms that have size, scope and network advantages are being constrained to accommodate firms that have a high risk of failure or are unproven in their ability to provide coverage and service to a broad array of Canadians.
22. The limited amount of 700 MHz spectrum that is likely to be made available, coupled with the favourable characteristics of this spectrum in terms of providing continuity of coverage and coverage in low-density areas might make the stakes particularly high and the trade-offs particularly stark. If caps and set-asides preclude, for instance, a successful Canadian incumbent from offering service using 700 MHz spectrum, does that make the country better off? As an example, one might face a choice between having rural and low-density parts of Ontario served by three well-scaled incumbents that can also bundle

⁶ In the conceptually simplest case, the same output is produced with more total fixed and sunk costs involved.

wireless broadband and voice with other services⁷ and eliminating one or more of these incumbents from the wireless broadband menu and replacing it with a stand-alone wireless firm such as Globalive or Mobilicity. Industry Canada should realise that these two options are not equivalent.

23. Without set-asides, Canada would benefit from three vibrant operators that offer LTE services nationally. *With* set asides there is a very real danger that there will be but a single quality LTE network that competes with two or more lower-quality networks and even some chance that if all of the spectrum in this auction is set aside that in some regions of the country there might not be a single high quality LTE network.
24. Incumbent firms are more likely to bump up against capacity constraints (as a result of rapid growth in mobile data traffic) in the near term than they were in 2008. This raises the costs associated with a misallocation of spectrum, especially because such a misallocation cannot be corrected in a frictionless and instantaneous fashion. A set-aside was not likely required in order for new entrants to win large amounts of spectrum in 2008, and it is not required today. At the same time, the costs associated with a misbegotten set-aside of a large amount of spectrum are even higher than they were back then.
25. What applies to set-asides applies generally to other “affirmative” spectrum policies such as spectrum aggregation limits or “spectrum caps.” There are institutional and mechanistic aspects of such caps that are especially problematic. We note that caps were used in North America in the 1990s and early 2000s, and then discarded. We thus find it interesting that they are under discussion again. In fact, in Canada, these caps were discarded in 2004, the year that Rogers Wireless acquired Microcell, and thus the industry arrived at the configuration of three roughly balanced players). Looking back at what was being said in 2004, Industry Canada and the Competition Bureau appeared rather relaxed about developments in the Canadian wireless market, and the fact that there were only three competitors appropriately did not create concerns about a lack of competition in the market.
26. Currently, there appears to be around 265 MHz of licensed spectrum (for mobile services) available in Canada. Even the most conservative forecast that the ITU has prepared regarding spectrum demand suggests that around 1300 MHz of spectrum might be needed by 2015.⁸ Even if only half that demand actually materialises in Canada, this still suggests that substantially more spectrum needs to be licensed for commercial mobile services. Industry Canada’s focus should thus be on making more spectrum

⁷ A major limitation of the debate that this paper engages with is that it fails to acknowledge that there is increasingly an integrated communications market—that is, consumers and businesses want to access video, voice and data communications inside the home and outside the home. Thus there is no “wireless market” that operates in its own silo, although that is the working assumption one has to make to engage with the policy debate on spectrum.

⁸ ITU, “Estimated Spectrum Bandwidth Requirements for the Future Development of IMT-2000 and IMT-advanced”, <http://www.itu.int/publ/R-REP-M.2078-2006/en>.



available⁹ and less on a policy that has echoes of old fashioned “industrial policy.” Such an increase in spectrum availability is also the most effective “pro-competition” tool available to Industry Canada, since it allows entrants to acquire spectrum without substantially impeding the efficient expansion of incumbent firms.

27. The outline of the rest of this report is as follows. In Section 2, we review what the appropriate goals should be for spectrum policy. Section 3 then considers the evolution of competition in the wireless sector in Canada since 2004, casting considerable doubt that Canada’s market either underperforms or has less competition relative to other countries. In Section 4 we use international evidence to establish the range for the natural limit and why it casts substantial doubt on the prospects for viable further entry in the wireless market. In Section 5 we consider the circumstances when incumbents would have an incentive to bid more than the value of spectrum in use to deter entry and show that they *are not applicable to the 700 MHz auction*. In Section 6 we consider the efficiency of further entry that is reliant on set-asides or aggregate spectrum caps, explaining why the benefits are likely small and the costs significant. In Section 7, we comment on the disconnect between the way Industry Canada defined “incumbents” and “entrants”, and any reasonable geographic market definition.

2. APPROPRIATE GOALS FOR SPECTRUM POLICY

28. What should really matter in Canadian spectrum policy? There is general consensus that spectrum is a highly valuable and *increasingly* valuable resource; there is also consensus that spectrum allocation policies should reflect the need to incentivise economically efficient spectrum use. There is less of a consensus on whether or not spectrum “scarcity” is real or somewhat artificial (caused by governments, for example, misallocating spectrum to socially sub-optimal uses). The appropriate pricing of spectrum remains an important issue — since the right pricing mechanisms are vital to securing economic efficiency.
29. However, there is confusion about the appropriate concept of economic efficiency to be deployed in this context. The literature on spectrum allocation¹⁰, with its focus on auction design, tends to emphasize revenue-generation as an attractive property of auctions. Economic efficiency is claimed not by virtue of overall consumer welfare, but merely by virtue of the spectrum ending up in the hands of the buyer that values it most. But at least some uses of the spectrum generate substantial positive externalities—

⁹ It should also be on fostering the development of spectrum secondary markets so that spectrum can be efficiently reallocated.

¹⁰ We use the term “spectrum allocation” rather than “auction” advisedly. In our view, the allocation process consists of primary allocation mechanisms (of which auctions are one part) and secondary trading which is vital to ensuring that spectrum continues to remain in the most socially efficient uses and that pricing of spectrum reflects the continuous stream of information that is available to the industry.

consumer surplus, in other words—for the Canadian public, and that such consumer surplus far outweighs the return that the Canadian public would get by allowing the spectrum to be put to some other “next best” use. Hazlett and Munoz (2004) calculate that annual consumer surplus from mobile telephony is orders of magnitude above the revenues that spectrum pricing and allocation processes generate for governments.¹¹ Similarly, Cramton *et al* (2010) make the case that policies that maximise innovation and end-user benefits from deployment of innovative wireless services that utilize the spectrum are the ones that maximise economic efficiency.¹² If there are perfectly competitive markets downstream, then revenue-maximisation for the government is synonymous with welfare-maximisation, but such conditions may not hold in reality.

30. Auctions have thus far shown attractive revenue-generating properties for government. In fact, as a revenue-generating mechanism, auctions are superior to taxation, as they represent a simple transfer from producers to the government, as opposed to taxes, to which firms and workers can respond by reducing their supply of labour or reducing their taxable earnings. A conventionally accepted result is that this dead-weight loss from taxation is equivalent to about 1/3rd of the revenue generated.
31. By contrast, auctions are non-distorting and can raise revenues in the billions of dollars. Thus, the 2008 AWS auction in Canada raised a total of \$4.3 billion, while the 2001 PCS auction raised \$1.5 billion. Overseas, auction receipts have been in the tens of billions of dollars: in the 2000 auction of “3G” (1800 MHz) spectrum in the U.K., the U.K. exchequer raised as much as 600 Euros per head of population, a number that was almost matched in Germany.
32. It can be shown that using an assumed social discount rate of 5%, an *annual* flow of \$556 million over a ten-year period yields the same present value as the \$4.3 billion raised in the 2008 AWS auction. This annualized auction revenue can be compared against the estimated consumer surplus obtained from wireless services in Canada. Hausman (2002) and Hazlett and Munoz (2004) suggest that annual consumer surplus from wireless services roughly equals total wireless revenues.¹³ In Canada, these annual revenues were roughly \$17 billion in 2009.¹⁴ While it is not possible to gauge how much annual revenue was attributable to the spectrum that was actually auctioned off in the AWS auction, it is not unreasonable to suppose that the eventual annual consumer benefit just

¹¹ Hazlett, Thomas and Roberto E. Munoz (2004), “What Really Matters in Spectrum Allocation Design”, AEI-Brookings Joint Center for Regulatory Studies, Working Paper 04-16, August 2004.

¹² Cramton, Peter, Evan Kwerel, Gregory Rosston and Andrzej Skrzypacz (2010), “Using Spectrum Auctions to Enhance Competition in Wireless Services”, obtained from Regulation2point0.org.

¹³ Hausman, Jerry A. (2002), “Mobile Telephone”, Chapter 12 in M.Cave et. al. eds, *Handbook of Telecommunications Economics*, North-Holland (Amsterdam). Also see Hazlett and Munoz, *op.cit.* Note that Hausman’s simplified calculation of “compensating variation” suggests that this equals (0.5 x Annual Revenue) divided by the price elasticity of demand. Since Hausman calculates this elasticity to be roughly -0.5, he calculates that the compensating variation roughly equals annual revenue.

¹⁴ Source: CWTA. <http://www.cwta.ca/CWTASite/english/index.html>.



from utilization of this new spectrum (whose uses are still being developed) will be several multiples of the annualized revenue flow.

33. On the other hand, suppose that the government adopted policies that effectively delayed the deployment of a valuable new service such as wireless broadband. Such delays could occur because, for example, the government was worried about how much money it could raise in an auction at the current time—indeed, concerns about the ability to meet reserve price requirements led to a two-year delay in the Indian 3G auction. Suppose further that the annualized revenues from wireless broadband grow according to the schedule in **Table 1**. In this example, revenues from the service will peak about 5 years after its initial deployment and the service becomes obsolete (is retired, or stops generating revenues) some ten years after its deployment.
34. The last column in the first row shows the present value of consumer surplus generated by the service if it is deployed immediately. The last column in the second row shows the present value of consumer surplus if the service is deployed with a two-year delay.¹⁵ The difference in net present value of the social surplus between the two scenarios is around \$1.8 billion. This is simply a direct social cost, assuming that investment and demand are essentially unaffected by the delay.¹⁶
35. Consequently, the total (direct and indirect) costs of delays and regulatory opportunism in the spectrum allocation process might be truly significant. Even a mere two-year delay causes around 10% of total surplus to be lost.
36. In short, the spectrum allocation process should give low weight to government revenue considerations and much higher weight to allocations that lead to the timely deployment of wireless services, and to efficient wireless competition. As a result, spectrum allocation policies that aim to promote competition should do so with great care. As Cramton *et al* (2010) note there is a trade-off between competition and scale in the wireless industry. They describe this trade-off as being a “difficult” one, between the potentially important benefits such as “higher social value from concentrated ownership of spectrum,” and competition which can accelerate the deployment and adoption of new services.¹⁷
37. It is in this context that policies such as set-asides and spectrum aggregation limits become relevant. Such policies are founded on a belief that incumbent network owners

¹⁵ However, the simulation realistically assumes that there is some catch-up that occurs under the “delay” scenario—i.e., even if service were deployed two years late, this does not mean that there is a two-year delay in achieving a particular diffusion rate.

¹⁶ That is, the delay does not itself cause operators to change their investment outlays nor does it change the underlying demand for the product. The investment simply shifts two years into the future. However, if wireless operators come to expect that instead of timely auctions (or other allocation mechanisms) to release additional spectrum, the spectrum allocation process is primarily driven by government rent-extraction requirements, this will result in more cautious investment by these operators.

¹⁷ Cramton *et al*, *op.cit*, at pp.2-3.



have strong incentives to “overbid” (pay above the mere “use value” of the spectrum) in order to keep entrants out of the market. If entry is likely to be beneficial to the market, and entry would not occur with a set-aside or without the use of some other “affirmative”¹⁸ policy such as a spectrum cap, then these policies might be worth considering.

38. Thus, the first important question to consider is whether there is insufficient competition in the first place, and whether there is actually room for further efficient entry. The analysis that we conduct in this paper suggests that, in fact, there is not any evidence of insufficient competition in the Canadian wireless market, a finding that in itself casts significant doubt on the wisdom of a set-aside. As it happens, the same factors that suggest that there is not insufficient competition in the market also suggest that the incentives for incumbent firms to overbid in order to deter entry are weak.

3. “INSUFFICIENT” COMPETITION?

39. The primary exhibit used to make the point that Canada’s wireless market is not sufficiently competitive is Canada’s low wireless penetration rate. This low wireless penetration rate is linked to the fact that there are “only” three national wireless carriers in Canada (even though there are now in fact four, five or even more facilities-based carriers serving each major Canadian market) in order to make the connection between competition and outcomes.
40. However, there are two problems with trying to make this link between market structure and market outcomes. The first problem is that the wireless penetration is “low” in comparison with the penetration rate in other countries but not “low” in any absolute sense, as there are more than 70 wireless subscribers per 100 persons in Canada. Further the penetration rate in other countries (particularly in Europe) is significantly distorted by a variety of institutional quirks. In fact, the penetration rate that is commonly cited is “subscribers per 100 persons.” This penetration rate is nothing more than the number of SIM cards or SIM card equivalents per 100 persons. In many countries, because of factors such as termination rates that create a wedge between the pricing of “on-net” calls and “off-net” calls, people have incentives to take out multiple subscriptions and use multiple SIM cards to get the best calling rates for different sets of contacts or callers. Further, many wireless operators might find it difficult to keep track of inactive pre-paid subscribers (and in European countries, pre-paid subscribers are the majority) and these may continue to be counted in subscriber tallies.
41. Waverman and Dasgupta (2010) explain some of these factors at length, and explain how they inform a major difference between the “penetration rate” as commonly measured, and the penetration rate as it ought to be measured — the proportion of the population

¹⁸ The term “affirmative” is used in this paper as a shorthand for policies that consciously create asymmetries between entrant and incumbent firms, or place restrictions on incumbent firms (in particular), in order to promote further entry and competition.

that uses a wireless phone.¹⁹ The evidence suggests that while the headline penetration rate (the one that is commonly cited) is as high as 150 subscribers per 100 population, in some European countries the actual penetration rate is more like 80 to 90 users per 100 population.

42. Many of the institutional features that drive this difference between the two measures of “penetration rate”—the use of calling party pays, high call termination rates, and the predominance of pre-paid—are not present in Canada. The difference between Canada’s headline penetration rate and its penetration rate on a “users per 100 population” basis is likely to be far more modest than is the case for Europe. In other words, a large portion of the penetration gap between Canada and foreign countries is simply an artefact of poorly measured and poorly understood data. To the extent that the Canadian penetration rate is still lower than that in other countries, is likely to be the result of the very high level of development and affordability of the Canadian fixed-line network.²⁰
43. The second issue with blaming Canada’s “low” wireless penetration rate on a lack of competition is that it is not at all obvious that Canada’s wireless market is less competitive than that of other nations. **Table 2** shows that Canada’s market is less concentrated than most of the other markets in the OECD in that table, even though they all have much higher penetration rates. This is true when one looks at Herfindahl-Hirschmann Indices (HHI), at the share of the top two firms in the market, and at the number of competitors (at a national level) in the market.
44. In fact as **Table 2** demonstrates, there is simply no correlation between “market structure” and penetration. For example, Greece has an HHI of 3630, indicating a more concentrated market than Canada, but it has a headline penetration rate that is twice Canada’s, and ahead of those of the much less concentrated U.K. and U.S. markets.
45. Further, there are other measures of wireless performance by which Canada is actually a very good performer. One of these measures is “minutes per capita”, which is (minutes per subscriber) x (subscribers per capita). The advantage of using this as a measure of industry output is that it “cancels out” two simultaneous distortions that apply to European data (in particular) — the over-statement of “subscribers” and the attendant under-statement of “usage per subscriber.” (If “subscribers” and “users” corresponded perfectly well, such a distortion would not exist). By this measure, Canada’s performance is much better than that of many European countries, as shown in **Figure 1**.
46. These international comparisons aside, it is also worth noting that the Canadian market has shown substantial evolution since 2004. 2004 is an interesting year to use as a benchmark. In that year, Industry Canada removed the spectrum cap (a limit of 55 MHz of licensed spectrum per carrier in each geographic market) that it had been applying so

¹⁹ Dasgupta, Kalyan and Leonard Waverman, “Canada’s Broadband Performance: Relevant Considerations for a Digital Economy Strategy”, October 11th, 2010, report prepared for BCE Inc. and Telus Inc. See particularly Section 5, which discusses a number of factors relevant to the wireless market.

²⁰ Quigley, Neil and Margaret Sanderson, “Going Mobile –Slowly”, C.D Howe Institute, Commentary No. 222, December 2005.



as to assist entry and the development of the market. Further, Rogers Wireless acquired Microcell, which had emerged from bankruptcy. The Competition Bureau in approving that acquisition showed a relatively relaxed view of the state of competition in the Canadian wireless market, concluding that it was “vigorous and effective” while simultaneously acknowledging that further facilities-based entry was highly unlikely.²¹ Given these conclusions—implicit and explicit—that were made in 2004, it is surprising that at least implicitly Industry Canada has concluded that there is not sufficient competition (hence its efforts to insert more competition in the market via spectrum policies that allocate spectrum to entrants on a favourable basis).

47. Analysing the growth of the market since 2004, we find:

- Penetration in Canada has continued to grow at a comparable rate to that in the United States and far higher than in the U.K (the U.K. may have been saturated earlier) (**Figure 2a**). Penetration measured in the “SIM card per 100 population” fashion has grown by over 65% in the years between 2004 and the present (**Figure 2b**);
- There has been strong growth in data cards and data services revenue (**Figure 3**);
- Minutes of use in grew strongly in the mid-2000s, from 338 minutes per subscriber per month to 406 minutes per subscriber per month, before following a North American trend and falling somewhat as consumers substituted data communications for voice (**Figure 4**);
- Both “Aggregate Minutes of Use” and “Minutes per capita” (which is a useful measure of wireless industry output because it measures aggregate usage, and then normalises it) have grown strongly in Canada over the last five years (**Figure 5**);
- There has been substantial capital investment in the industry, and Canadian operators have remained more capital-intensive than their European counterparts over the past decade (**Figure 6**). The three Canadian incumbents have invested more than \$10 billion in networks since 2004;
- In nominal terms, voice revenue per minute has fallen from a country average of around 13 cents in 2004 to 11 cents in 2009.²² In real inflation-adjusted terms, the price decline has been in the order of 25 percent. Unlike in other countries where regulatory-imposed cuts to mobile termination rates have been the primary driver of declining per minute revenues, in Canada, voice revenues per minute have fallen because competition continues to constrain prices;
- Average Revenue per User (ARPU) has increased in Canada from around \$51.5 to \$58.33, a nominal increase of around 14% and a real increase of around 2%. However, a lot of this increase in ARPU is because of a substantial increase in ARPU

²¹ See Competition Bureau, “Acquisition of Microcell Telecommunications Inc. by Rogers Wireless Inc.”, *Technical Backgrounder*, April 12th 2005.

²² Source: Merrill Lynch Global Wireless Matrix, Q3 2010.



for Rogers Wireless, from \$47.17 to \$63.32. This reflects two things: (a) Rogers was offering GSM technology whose relative attractiveness to high-value customers (e.g., those who travel internationally) increased steadily through the mid-2000s, (b) Rogers' average Minutes of Use increased very sharply from 394 MoU to over 500 MoU per month over this period. Rogers' per-minute prices declined slightly over this period. Thus Rogers' superior financial performance in the mid-2000s owed to its choice of technology and its innovation in services. Instead of promoting exit from the industry, however, this has led to a competitive response from Bell and Telus, who have migrated their networks onto the GSM path and are competing with Rogers for the fast-growing data market.

48. Consumer preferences are changing because of the importance of smartphones in the consumer consciousness. As a result, the Canadian market is seeing increasing numbers of customers moving to contracts rather than taking up pre-pay plans.²³ Thus even as the aggregate market has grown, the share of pre-paid subscribers in all subscribers has fallen slightly since 2004. This suggests that consumers value "quality" as well as price, and the notion that Canadians would flock to European-style pre-pay plans if only they were offered, does not seem empirically valid. In fact contrary to assumptions made in Europe, there is solid evidence to show that consumers place considerable value on "big buckets of minutes" plans because of the certainty that they afford and would prefer such plans to intensively metered plans (although some level of metering, if it means lower prices, might be preferable than "unlimited" plans). Thus popular concerns about consumers being pushed into contracts that they do not want and would not accept if they had a choice simply do not seem true.²⁴
49. The evolution of the Canadian wireless market is at odds with the usual competition policy concerns surrounding oligopolies that curtail output and raise prices. Prices have (in real terms) fallen a good deal, output (whether measured in total minutes or in total subscribers) is substantially higher, and most notably, there has been a wave of innovation in the industry. Even though some of this "progress" in the Canadian industry is really the result of wider technological progress, being experienced throughout the globe, the reality is that Canada has not been a bystander or a backwater in this regard. The deployment of new HSPA+ networks, for instance, puts Canada well ahead of several European nations and the United States in the "mobile broadband race." The high capital intensity of the Canadian wireless industry relative to its international peers also seems incompatible with a view of a passive oligopoly that is behind the international leading edge of mobile deployments. In fact, a sober analysis would suggest that Canada has come to be something of a leader in deployment of advanced data networks, something that it could not have claimed in 2004.
50. Looking at the data, one sees little reason to alter the conclusions that were reached in 2004 regarding vigorous and effective competition. That is precisely what one sees in the

²³ *Ibid.*

²⁴ Fishburn, P. C., Odlyzko, A. M. and Siders, R. C. "Fixed fee versus Unit Pricing for Information Goods: Competition, Equilibria, and Price Wars", *First Monday*, vol. 2, no. 7 (July 1997).

growth, investment and pricing data relevant to the last few years. On the face of it, if Canada's authorities were relatively relaxed about the consequences of a market structure in which there were three major national firms, they should be at least as relaxed about the same market structure today.

51. Looking at Canada in comparison with other countries, the Canadian market is obviously less concentrated than a number of other markets around the world. "Insufficient competition" is not the reason behind Canada's lower wireless penetration rate relative to other countries, and Canada's good performance on broader and arguably more valid metrics of industry output and performance also belies the notion of "insufficient competition." We note here that it would be rather difficult for competition to be "vigorous and effective" while also being "insufficient."
52. We turn next to a fundamental feature of wireless markets around the world and in Canada, a feature that is apparent when one looks at **Table 2**. Markets everywhere are concentrated, and the number of competitors in the various markets in **Table 2**, shows limited variation. This fact illustrates that there almost certainly are hard "natural" limits to the amount of entry that can be sustained in wireless markets. In most countries, there are three to four national competitors, and where there are as many as four or five competitors, a closer examination of the data shows that the fourth and fifth competitors tend to be marginal. In one case, the U.K., the number of competitors in the wireless market is set to fall following consolidation. Such consolidation has also happened in other markets around the world, such as the U.S. We elaborate on these themes in the next section.

4. "NATURAL LIMITS": INTERNATIONAL EVIDENCE

53. The first importance facet of the real world is the striking regularity in concentration and levels of entry across global wireless markets. We see that larger countries such as the United States, Japan and Germany do not have far more participants in the wireless market than smaller countries. In the economic framework established by Sutton (1991) such regularities in concentration are the product of high set-up costs relative to the size of the market.²⁵ In the telecommunications market, including wireless, high sunk costs and economies of scale and scope put hard limits on the number of firms whose participation can be sustained in the market. **Table 2** also summarises concentration levels across the world, looking at (a) the HHI (b) the share of the market held by the top two firms, and (c) the number of competitors. These data suggest that it is difficult for a national wireless market to sustain more than four competitors, and that in many cases,

²⁵ This is true whether the set-up costs are "endogenous" (i.e., determined by choices that firms make, such as how much to invest in quality, product variety and advertising), or exogenous (the economics of a complex network designed for providing coverage over a large area). Sutton, John (1991), *Sunk Costs and Market Structure: Price Competition, Advertising and the Evolution of Concentration*, (Cambridge, MA: MIT Press).



two or three firms have overwhelming collective market share. The data also show that the Canadian wireless industry is not overwhelming concentrated and is in fact well within global norms of concentration.

54. The United States and Canada have regional entrants in the wireless market, and the FCC's 14th CMRS report suggests that roughly 30% of the U.S. population is served by six or more facilities-based providers. However, the U.S. industry has been consolidating steadily since the early 2000s, and market share has significantly shifted to the two leading players, whose share at a national level has gone to about 60%. In fact, in 2000, around 39% of the U.S. population lived in areas where there were six or more providers.²⁶ This consolidation has occurred over a period in which penetration has more than doubled, tens of billions of dollars has been invested in wireless voice and broadband networks in the U.S., and the U.S. has the highest level of mobile telephone usage in the world. In fact, the U.S. today is the only country in which a mobile phone can be used more or less interchangeably with a fixed-line phone, as there are no national roaming charges and no specific long-distance charges within the U.S. Absent consolidation, these special features of the U.S. market would never have developed. In Canada, too, the market has developed significantly in the face of consolidation. For instance, mobile lines per 100 individuals have grown from around 47 in 2004 to an anticipated 73 at the end of 2010.²⁷ Over the period 2004-2009, the combined capital expenditure made by the wireless divisions of Bell, Telus and Rogers has been around \$10.4 billion, or roughly 15% of revenues over this period.
55. Thus not only has consolidation been a quite natural trend observed across the American, European and Canadian telecommunications industries, it has also likely been a beneficial trend.
56. Further, the history of new entry into the wireless market since 2000 is a discouraging one. Hutchison, the Hong-Kong based conglomerate, has found expansion in Australia and Europe rather difficult. Other than in Italy, it has below 10% market share in all the European countries in which it operates, and at best, has been able to eke out a few quarters of positive earnings. However, the firm's European operations have never—over the better part of a decade—generated positive cash-flow in a single quarter.²⁸ The cumulative negative cash-flow of Hutchison Europe since its launch runs into several billion dollars. In Australia, Hutchison and Vodafone (the third and fourth players in the market) merged their operations in 2009. The Australian Competition and Consumer Commission cited these firms' financial performance as a major constraint on their ability

²⁶ Federal Communications Commission, *14th Report on Competition in Commercial Mobile Radio Services* ("14th CMRS Report") (current data) and *5th Report on Competition in Commercial Mobile Radio Services* (2000 data at Tables 2A-2C). Note that the older reports use counties as the unit of coverage and the newer reports use census blocks, making exact comparability difficult.

²⁷ Source: Merrill Lynch Global Wireless Matrix.

²⁸ Hutchison's financial reporting does not enable us to estimate cash-flow and earnings on a detailed basis for its individual operations in each country.

to continue investing and expanding their networks.²⁹ This echoes Canada’s own experience with Microcell.

57. Hutchison’s experiences are not unique. In aftermath of the European 3G auctions, several operators that were successful at auction could not eventually compete to offer services in the market, or only launched after very substantial delays. Examples include Group 3G, Mobilcom and Yoigo (which did launch in 2006, three years after the stipulated date in the license), all of which were successful licensees but whose actual operations proved unviable or were severely hobbled. These firms had support from major “parents” such as France Telecom and TeliaSonera, just as Hutchison was part of a vast multinational conglomerate.
58. In the United States, consolidation rather than new entry has been the norm. T-Mobile USA might be considered a “new entrant” since 2000, but in reality it was formed from the purchase of the assets of VoiceStream Wireless by Deutsche Telekom, and VoiceStream itself had acquired the assets of several other U.S. wireless operators. Clearwire might be considered a new entrant, although it is majority owned by Sprint. In any case, its success is far from established or even detectable (despite an abundance of spectrum available to it).
59. Meanwhile, consolidation has also begun to characterise the European wireless markets. In the Netherlands, the number of operators has gone from five to three in the last five years with the take-overs of Telfort by KPN and of Orange by T-Mobile. In the U.K., Orange and T-Mobile have also merged their operations. Indeed, were it not for the perhaps overly narrow approach that competition authorities take to assessing the impact of mergers (concentrating on static efficiencies, and (outside Canada) not explicitly incorporating a “social surplus” standard into merger reviews), it is likely that Hutchison would have sold its European operations off to other firms instead of continuing to sustain large financial losses.³⁰ In the face of antitrust constraints, European firms have also been very active in launching network-sharing agreements. Examples of these include Vodafone and Telecom Italia in Italy, T-Mobile and 3 in the United Kingdom, Orange and Vodafone in Spain, and a tri-lateral agreement between SFR, Bouygues and Orange in France (even though these three firms have previously been found guilty of operating a cartel by the French competition authority). These network-sharing agreements do, however, reflect cost pressures on “stand-alone” networks.
60. We are not aware of any successful fourth or fifth operators that have successfully entered European or other developed country wireless markets since 2000. The U.K. and some other countries had four established operators prior to 2000, and the U.K. even could claim four relatively evenly balanced operators prior to that date, but this entry occurred in the mid-1990s, when the market was in a nascent state of development.

²⁹ Australian Competition & Consumer Commission, 2009. *Public Competition Assessment: Vodafone Group plc and Hutchison 3G Australia Pty Limited – proposed merger of Australian mobile operations.*

³⁰ Speculation about the future of Hutchison-UK has been occurring for some time. See for example, http://www.theregister.co.uk/2010/03/05/vodafone_3_uk_deal/

61. Overall, the picture points overwhelmingly to a naturally concentrated market, whose boundaries are determined by the interaction between the costs of establishing a network and the demand that is available to be served. Consolidation rather than further “greenfield” entry seems to be the norm in the developed world. This strong suggestion of a natural limit on entry has profound implications for the advisability of a policy such as a set-aside, as we see subsequently. The international evidence is that there are at most three or four competitors that can be sustained in a wireless market, at least over any reasonably long time-span. Further, in most markets, two firms have more than 2/3rds of the wireless market, and the data also reveal that in most markets, three firms have more than 90% of the market (where there are four competitors). It is quite possible that many of the markets where there are currently four or more competitors will see further consolidation if competition authorities permit. It is worth noting too that the wireless industry in many countries has matured and blossomed at the same time as it has consolidated (e.g., in the United States).
62. In the next section, we discuss how this “natural limit” notion affects the analysis of policies such as set-asides and spectrum caps in the context of an over-arching theory of “pre-emption” which explains the circumstances under which incumbent firms will “overbid” (or alternatively “hoard”) spectrum to deter entry. The natural limit informs the likelihood of such a pre-emption strategy being exercised as one of the conditions under which pre-emption is less likely to happen.

5. AUCTIONS, SPECTRUM ALLOCATION AND PROMOTING COMPETITION

63. In Section 2, we had discussed the appropriate goals of spectrum allocation policy and concluded that auctions had come to be the preferred mechanism for primary spectrum allocation. One reason for this is that auctions raised revenues in a non-distorting fashion.
64. Besides their use as a relatively non-distorting way to raise revenue for governments, however, auctions have come into increasing use for another important reason. An auction is seen as transferring the scarce resource to its most productive user, the firm or bidder that values it the most. However, there are some instances in which this “highest bidder” rule may lead to monopolisation of the market or foreclosure of efficient entry. When these circumstances apply, policies such as set-asides and spectrum caps³¹ might be used.
65. Essentially, problems of foreclosure (alternatively “pre-emption”) arise when an incumbent firm or incumbent firms perceive that the acquisition of spectrum by another party will pose sufficient threat to their profits that they are prepared to bid more than just the “use value” that they have for the spectrum.³²

³¹ Note that caps are not necessarily linked to auctions, but can work with other allocation processes (e.g., beauty contests) too.

³² The use value of the spectrum might be defined as the difference in (net present value of) profits that the firm can expect to make with and without use of the relevant spectrum assuming market structure is

66. In the first part of this section we provide a comprehensive review of the economic literature on pre-emption and foreclosure. We show that in theory there are a set of circumstances when it is profitable for incumbents to bid not only their use value but pay a premium for spectrum because it preserves their market power. We also show that in theory there are circumstances where this is not true. Whether incumbents have an incentive to overbid to preserve their market power depends on the facts. In the second part of this section we explain that the facts in the wireless industry in Canada are consistent with the circumstances under which incumbents will not bid a deterrence premium. In the third part of this section we provide evidence from other jurisdictions that entrants can and do outbid incumbents for spectrum at auctions without any set aside or similar policy in place.
67. The basic pre-emption theory used by proponents to justify set asides is unlikely to hold the greater the uncertainty regarding whether the entrant will actually enter, the less entry reduces the market power and profits of an incumbent, and the greater the time it takes the entrant to enter. Moreover, three other factors reduce the incentive of an incumbent to pre-empt entry. The greater the number of incumbents, the greater the number of potential entrants, and the more optimistic the entrants' expectations regarding profitability, the more difficult it is for incumbents to pre-empt entrants.

5.1. **The Theory of Pre-emption**³³

68. In this part we first carefully develop the argument for pre-emption, i.e. that an incumbent will bid more than an entrant because foreclosing entry preserves market power. Gilbert and Newbery (1982) provide a simple and powerful model showing the conditions under which an incumbent firm would outbid an entrant for a scarce resource in order to preserve market power.³⁴ In their model, an incumbent monopolist faces off with a potential entrant to secure a resource or input that is used in the production of a good in the downstream market. Spectrum would be an example of such a resource.
69. Initially, the incumbent monopolist controls all the available stock of this scarce resource, which for convenience we shall call "spectrum." Gilbert and Newbery then model the outcomes that would materialise when an additional incremental amount of this "spectrum" becomes available. If this spectrum is won by the entrant, the market

constant. So if an incumbent monopolist wins it, the use value is the difference between being a monopolist with and without that spectrum, whereas if an entrant wrests it away from the monopolist, the use value is equal to its duopoly profit.

³³ This exposition is derived from teaching notes prepared by Dr. Jeffrey Church, Professor of Economics, University of Calgary, and Director, Berkeley Research Group, LLC. We are indebted to Dr. Church for sharing these notes with us and commenting on this exposition.

³⁴ Gilbert, R.J. and Newbery, David (1982) "Pre-emptive Patenting and the Persistence of Monopoly", *American Economic Review*, 72, 514-26.



structure changes from monopoly to duopoly. If the spectrum is won by the incumbent, the market remains monopolised. The key factor governing the incumbent firm's incentives to outbid the entrant is the difference between the profit streams that it will receive under monopoly and under duopoly.

70. There is an asymmetry between the bidding incentives of the incumbent firm and the entrant firm, however. This asymmetry is caused by the fact that the incumbent is motivated by the desire to protect the profit it realises from its current monopolistic control of spectrum. The entrant on the other hand simply will bid an amount equal to the profits that it expects to receive from the *use of the spectrum*.
71. To make this concrete, consider the following scenario. An incumbent firm has 20 MHz of spectrum available to it. From this it anticipates that the net present value of its profits is \$50 million. An additional 5 MHz of spectrum becomes available. If the monopolist secured this spectrum, two things would happen: (a) it would remain a monopolist, and (b) it would be able to aggregate the 5 MHz with its current spectrum holdings. Thus, if this firm secured control of the additional 5 MHz, its anticipated profit level would increase to the profit level of a monopolist with 25 MHz of spectrum available to it. Call this profit level \$65 million.
72. The entrant, even if it were able to win the 5 MHz spectrum, would still have to compete with the incumbent firm armed with 20 MHz of spectrum. Thus it would only bid an amount equal to the *duopoly profits* available to a firm that holds 5 MHz of spectrum. Suppose this amount is \$15 million. If the incumbent let the entrant win this amount of spectrum, its profit level would be diminished too because it would no longer be a monopolist. The profit level would be equal to the duopoly profits available to a firm with 20 MHz of spectrum, say \$30 million.³⁵
73. We know that the entrant would only bid \$15 million. How much would the incumbent bid? The answer is that the incumbent would bid the difference between what profit it would get if it won the additional spectrum and the profit it would get if it allowed that spectrum to slip away. This is \$65 million less \$30 million, or \$35 million. When the incumbent wins the 5 MHz of spectrum, it benefits in two ways: it gets to keep its monopoly, and it gets additional resources that can lower costs or otherwise boost profits.
74. Not only does the incumbent win the spectrum, but it bids more than the spectrum is intrinsically worth to it. We know this because the increase in profits purely as a result of acquiring the additional spectrum is \$65 million less \$50 million, or \$15 million. Call this value the “use value” of the additional spectrum. This is also the amount that the entrant would gain if it were able to win the spectrum. But the incumbent firm bids far above its use value, whereas the entrant firm bids exactly its use value. The desire to protect its market power is what drives the incumbent to (a) outbid the entrant, and (b) pay a premium above its use value for the spectrum.

³⁵ The numbers are intended for exposition, and not intended to be realistic reflections of how profits increase or decline with changes in spectrum ownership and market structure. For instance, one would usually expect duopoly profits to be less than half of monopoly profits.

75. There are good reasons for us to expect that a dynamic similar to that described in our contrived example might unfold. The monopolist could set the same prices and outputs as when there is a duopoly and thus could at least do as well it might under duopoly, and in general, will be able to do better since competition is eliminated.³⁶ This result that a monopolist will outbid an entrant for access to an essential input in order to keep that entrant out of the downstream market is known as the “efficiency effect”. The “efficiency effect” would not apply when there is collusion between the entrant and incumbent, or when the additional input that becomes available allows the entering firm to replace the monopolist. For example, this might happen if the spectrum that is available is of substantially superior quality to the spectrum that the monopolist actually holds.
76. In the example above, the monopolist is the highest bidder but its high bid is motivated by its desire to protect its profits from its existing license. The entrant has the same use value as the monopolist for the spectrum, but it is kept out of the market. When the “efficiency effect” of Gilbert and Newbery applies, there could be situations in which an entrant would be the best user of the spectrum from society’s perspective but is kept out of the market because it cannot match the “pre-emption” premium that the monopolist pays for its spectrum. These are the conditions under which society would be made better off by a policy such as a spectrum set-aside that allows the efficient entrant to secure the resource.
77. Arrow (1962), however, points out that a secure monopolist that is not worried about the scarce resource being acquired by an entrant will only be willing to pay the use value of that scarce resource.³⁷ Applying this to our example above, the monopolist is willing to pay the difference between being a monopolist with access to 20 MHz of spectrum and being a monopolist with access to 25 MHz of spectrum. The additional 5 MHz is now less valuable to the incumbent, since the incumbent does not need this spectrum to deter entry.
78. There is another potential effect that might apply here, which might motivate the entrant to outbid the incumbent. This is called the “replacement effect”, and it applies when acquisition of the additional amount of the scarce resource allows the entrant to supplant the incumbent and become the new monopolist. This may happen because the entrant is now motivated by all of the monopoly profit that will become available to it, whereas the monopolist is still only motivated by the difference in the profits from being a monopolist with its existing amount of the scarce resource and a monopolist with a little more of this scarce resource. In fact, the entrant might outbid the incumbent even if it does not drive the incumbent out of the market, but merely is able to dominate it.

³⁶ See Malueg, David and M. Schwartz (1991) “Preemptive Investment, Toehold Entry, and the Mimicking Principle,” *RAND Journal of Economics*, 22, pp. 1-13.

³⁷ See Arrow, Kenneth (1962) “Economic Welfare and the Allocation of Resources for Invention”, NBER Chapters, in: *The Rate and Direction of Inventive Activity: Economic and Social Factors*, pages 609-626, National Bureau of Economic Research.

79. This replacement effect becomes especially important if there is uncertainty regarding whether acquisition of the scarce resource will actually translate into entry. Reinganum (1983)³⁸ suggests that if the incumbent is reasonably confident that the entrant will use its acquisition of the resource to enter the downstream market, the efficiency effect will dominate the replacement effect and the incumbent will outbid the entrant. On the other hand, if this uncertainty is high, then the entrant might outbid the incumbent. Further, if the entrant is not likely to be a very effective competitor—that is, the entry makes little difference to the incumbent’s profits—then again the incumbent will not be motivated to pay a “pre-emption” premium³⁹. As well, the timing of the anticipated entry is material. If competition is unlikely to materialise for a while, then too, the replacement effect dominates the efficiency effect, and the less likely is a “pre-emption” strategy.
80. These last few conditions are especially likely to apply in the wireless market. The incumbent firm or firm(s) are likely to gain less and less from blocking entry as the number of entrants increases. This is a reflection of increasing uncertainty about whether entry will actually prove effective given the important fact that the wireless business is inherently concentrated because of its underlying technological characteristics. The industry is characterised by large sunk costs (particularly network construction costs) and high fixed costs, all of which imply that entry is difficult and that economies of scale make survival as a “fringe” player rather difficult. In fact, as we have noted, these very effects also give rise to concerns about the efficiency and social value of new entry into the wireless space.
81. Other considerations, many of which are realistic, also mitigate against the existence of pre-emption premiums. Specifically, the likelihood of pre-emption is reduced by (a) multiple incumbents, (b) multiple licenses, and (c) the possibility that entrants are quite likely to be more optimistic about their profitability than are incumbent firms (or the market as a whole).
82. Multiple incumbents matter because the impact of entry is borne by the entire industry, not just by one incumbent firm (although there are cases in which entry might have a disproportionate impact on one firm or a particular set of firms). If the profit impact of entry on a single incumbent firm is less than the profits gained by the entrant, then that incumbent firm will not want to outbid the entrant for a resource such as spectrum (Vickers (1985)).⁴⁰ Furthermore, it costs money to deter entry and if there is uncertainty about entry or its effectiveness, then the incumbent firms, acting individually, will tend to under-invest in deterring entry. This is essentially a coordination problem: all incumbent

³⁸ Reinganum, J.F., “Uncertain Innovation and the Persistence of Monopoly,” *American Economic Review* 73 (1983), 741-748.

³⁹ See Boone, Jan, “Intensity of Competition and Incentives to Innovate”, *International Journal of Industrial Organization*, 19, pp.705-726.

⁴⁰ Vickers, John (1985), “Pre-emptive Patenting, Joint Ventures and the Persistence of Oligopoly”, *International Journal of Industrial Organization*, 3, pp.261-273.

firms benefit from deterring entry, but each incumbent firm will have an inclination to free ride on the deterrence efforts made by its peers, with the result that no firm will spend enough deterring entry, and the possibility of entry is consequently enhanced.

83. Pre-emption can be very costly under certain circumstances. For instance, consider a monopolist that needs to buy many licenses to deter entry. The price that it has to pay to buy off each license equals the (duopoly) profit that each entrant acquiring those licenses would realise.⁴¹ The more such licenses there are, the more the likelihood that the incumbent will end up paying more than its monopoly profits to deter entry, and thus it will accommodate some entry.
84. Finally, the analysis of Gilbert and Newbery also handles asymmetric expectations between incumbents and entrants. There is some reason to believe that entrants with no experience of the market are more likely to overvalue their probability of success and thus experience some form of winner's curse (in other words, the winning bidder attaches a lot of value to something that turns out to deliver that winner far less value than was first anticipated).

5.2. **Should we expect to see pre-emption premiums in wireless?**

85. In Section 4 we argued for the existence of a natural limit and its applicability to Canada. The failure of new entry into mature wireless markets in other countries suggests that acquisition by entrants of spectrum does not imply actual entry or viable entry. Instead there will be considerable "uncertainty" regarding whether there will be actual entry or viable entry. Given the backdrop against which entry (or more accurately, acquisition of spectrum) into the Canadian wireless market is happening, there is a high probability that (a) spectrum licenses will not translate into entry or expansion, (b) that new entrants, faced with the huge barriers of capital expenditure and developing brands, products and supplier relationships, will not pose a substantial threat to incumbent's existing profits. The key here is that spectrum is not an output, it is an input, and it is only one of several hurdles that a firm has to surmount before it can operate successfully in the wireless market.
86. Thus, there would be substantial uncertainty about the entrants'/expanding firms' prospects, which in the theoretical analyses presented previously would suggest that the incumbents do not necessarily have incentives to foreclose entry. An important point here is that the expectations of incumbents and entrants regarding the entrants' likely profitability might be systematically different. Notably, entrants might have a tendency to over-estimate their chances of success in the market, hence their willingness to spend any money on spectrum at all.

⁴¹ Malueg and Schwartz, *op.cit.*



87. Two additional factors should be considered here. First, there is the obvious facts that foreclosing entry is costly because there are multiple licenses to be “bought off”, and secondly, there are multiple incumbents present.
88. The first factor, when combined with the uncertainty surrounding entrant prospects (or even intentions), increases the certain costs relative to the highly uncertain benefits of exercising a foreclosure strategy. As cited previously, Malueg and Schwartz (1991) note that (in a situation where a monopolist is threatened by multiple potential entrants) the price to deter each entrant equals duopoly profits. If there are sufficiently many licenses available, then the costs of deterrence might exceed the profits obtainable if all entry were successfully deterred (i.e., monopoly profits). Professor Michael Katz offers the following analysis⁴²:

Suppose that there are 270 MHz of suitable spectrum available for license in blocks of 30 MHz each. Also suppose that a service provider needs one such block in order to be a viable competitor. Lastly, suppose that incumbents currently hold licenses to 150 MHz of spectrum in some geographic market. Any one of the four remaining 30-MHz blocks could be used by an entrant to become a new competitor. Hence, an incumbent would have to purchase licenses for all four remaining blocks in order to deter entry. Thus, if an entrant were willing to bid up to \$50 million in order to obtain a 30-MHz license, the incumbent would have to spend \$200 million to block entry through spectrum warehousing.

Of course, as the total amount of spectrum available rises, it becomes even more costly for an incumbent to attempt to deter entry by warehousing spectrum. For example, if the total spectrum available is 650 MHz, then even if incumbents held 250 MHz of spectrum and an entrant needed 100 MHz to be a viable competitor, an incumbent would have to buy licenses for four times as much spectrum as would an entrant in order to deter entry. Moreover, for the right price, another incumbent might be willing to sell some its licenses to a potential entrant, thus increasing the amount of spectrum that an incumbent attempting to deter entry through warehousing would have to purchase.

89. Secondly, the fact that there are three roughly balanced incumbent firms active in the Canadian wireless market would create a significant free-rider problem. To our knowledge, there is no evidence from the 2001 PCS auctions or the 2008 PCS auctions that Canadian incumbent firms have colluded with each other in bidding on spectrum. Even more powerfully, as Vickers (1985) suggests, the impact of entry is borne by all incumbents, not just by a single incumbent firm. In this situation, the fall in a *single*

⁴²Katz’s example is a good illustration of Malueg and Schwartz (1991). See Michael L. Katz, “An Economic Analysis of the Rural Telecommunications Group’s Proposed Spectrum Cap”, December 2, 2008 (Filed as *Appendix A* to the *Opposition of Verizon Wireless*, RM-11498).



incumbent's profits after entry has happened, might well be less than the profits available to the entrant. Absent coordination, entry will not be deterred in this case.

5.3. Entrants do acquire spectrum without set asides

90. Our analysis of economic theory strongly suggests that there would be only limited (if any) incentives to foreclose entry into the wireless market. The predictions of this theory are, however, well supported in practice. Entry or at least successful spectrum acquisition has occurred in the absence of set-asides in many countries. Consider the following:

- In the European 3G auctions, Hutchison was the beneficiary of a set-aside in the United Kingdom, but was not the beneficiary of set-asides in other countries. However it was able to purchase licenses in Sweden, Denmark, Ireland, Italy and Austria, as well as the United Kingdom. These other countries used a variety of licensing processes, but it should be noted that in Denmark, where not only were no set-asides used but where the number of licenses on offer equalled the number of incumbent firms, Hutchison beat out Telenor, one of the incumbents, to win 3G spectrum;⁴³
- In the auctions held in Germany, the regulator made available twelve blocks of spectrum. There were four incumbent firms. The regulator stated that firms would have to purchase a minimum of two and a maximum of three blocks of spectrum. This meant that there would be at least four winners (equal to the number of incumbent firms) and a maximum of six winners. One might think that the end result of such an auction format would be that only the incumbent firms won licenses. In fact, six firms won licenses, the maximum of what was allowed by the auction format;
- Austria chose a similar format to Germany. Again, there were six bidders and a maximum of six potential licensees. In fact, each of the six bidders won the requisite two blocks, and there were some suggestions of tacit and not-so-tacit collusion between the six bidding firms. In other words, entrants and incumbents colluded to keep auction prices low, instead of incumbents aggressively pre-empting entry by purchasing a third block of spectrum;⁴⁴

⁴³ Sweden employed a beauty contest process. It should be noted that while some countries offered one more license than there were incumbent firms, and restricted each firm to just one license, this still did not equate to a set-aside of spectrum. In such a format, any firm can bid on any available block of spectrum, and thus unlike the set-aside there is no guarantee that entrants will pay less than incumbent firms.

⁴⁴ Klemperer (2002) reports the incumbent, Telekom Austria, as saying that it would be satisfied if simply won two blocks, but might consider bidding on a third block if someone else did. See Klemperer, Paul, "How (Not) to Run Auctions: The European Telecom 3G Auctions", available at <http://www.nuff.ox.ac.uk/users/klemperer/hownot.pdf>, at footnote 28.

- In the United States, a consortium of U.S. cable operators was the third largest winner of spectrum in Auction 66 in 2006, without a set-aside. Further, individual cable operators such as Cox were able to purchase even more spectrum in the 2008 auction of 700 MHz spectrum;
 - Also in the United States, the list of winners (of significant amounts of spectrum) in recent auctions includes firms such as Qualcomm that have never participated in the telecommunications service business.
91. One would infer from the theory and international evidence that the conditions that might justify instituting a set-aside of spectrum do not currently apply in the Canadian market, unless one can convincingly make the case that the behaviour of Canadian incumbents would be different from that of their foreign counterparts, even when they are confronted with similar circumstances. For example, it does not stand to reason that Canadian cable firms, in particular, would not be able to purchase sufficient spectrum in an open auction, given the experience in the United States. Thus it appears to us that at least some of the entry (especially by cable operators) that occurred following the 2008 AWS auction would have occurred absent a set-aside: a set-aside that was then almost certainly not necessary. It also appears that some, most or perhaps even all of the entry that occurred as a result of the 2008 set-aside policy might prove unviable. The underlying natural limits on how much competition can be sustained in the market restricts the prospects for further entrants which in turn influences incumbent firms' expectations regarding the profit threat posed by entry.
92. In this preceding section we have demonstrated that (a) there are circumstances under which pre-emption or foreclosure is a valid concern, (b) if those circumstances apply to the Canadian wireless market, then policies such as set-asides might be worth considering, but (c) those circumstances do not apply to the Canadian wireless market. The basis for (c) is that there is considerable uncertainty about the prospects (viability) of further entry into the Canadian wireless space, that there are multiple incumbents and that there are multiple licenses to be "bought off." Given the track record of entrants into mature wireless markets, it would be foolish for incumbent firms to spend large amounts of money foreclosing entry that is not sustainable. This does not preclude, of course, that incumbents might respond to competitive entry by changing pricing strategies and the like in particular market segments, but it would not seem sensible that incumbents in a market which is operating at about the natural limit.
93. Having established that a set-aside (or any other form of favourable allocation of spectrum to entrants, usually by restricting incumbents' ability to access spectrum) is not required in order to induce new entry/expansion, we next explain the likely costs and benefits of using a set-aside policy. It is worth noting that not only is a set-aside not required to promote new entry, but the entry it induces may not be particularly desirable. At the same time, the set-aside wastes a valuable resource—spectrum—and that resource wastage is itself very harmful to society. We then extend the discussion from set-asides to "spectrum aggregation limits" or "spectrum caps", the analysis of which is generally similar.

6. COSTS AND BENEFITS OF “SPONSORED ENTRY”

94. In what follows, we consider the costs (direct and indirect) of using spectrum set-asides to promote entry and competition. Specifically we note that set-asides raise acquisition costs needlessly for incumbent firms, and by doing so they may have longer-term impacts on such firms’ ability to invest. We then note that set-asides impose opportunity costs and resource waste, and distort the nature of competition in the market (for which we provide a specific Canadian example). More than this, set-asides might promote excessive amounts of entry. We remind the reader that in the wider economic literature, more entry is not always a good thing for society. We then briefly consider spectrum caps, since besides having the costs and benefits associated with set-asides, they also pose other largely institutional complications.

6.1. Set-asides raise incumbent spectrum costs

95. Dippon (2009) suggests that incumbent firms in the Canadian AWS auction significantly over-paid for their licenses for two reasons.⁴⁵ First, the fact that such a very large amount of spectrum was set-aside for entrant firms meant that supply of spectrum to incumbents was artificially restricted. Second, Dippon suggests that there may have been strategic bidding by entrant firms—who were allowed to bid on all spectrum blocks—which also raised the costs of incumbent firms.

96. While it is rather hard to evaluate Dippon’s argument regarding the impact of “fake bidding” by entrant firms, there is little doubt that reducing the supply of spectrum to incumbent firms intensified competition between these firms and increased their bids. “Open” AWS spectrum in Canada sold for three times the amount that would be predicted by a regression model of spectrum prices against market characteristics conducted by Dippon.

97. The impact of this “over-bidding” is non-trivial, even if the social costs of excessive payments are not direct ones. Excessive payments for spectrum licenses played a significant role in exacerbating the serious financial distress faced by some large European firms in the early 2000s. For instance, France Telecom faced a near-bankruptcy in 2002, while BT was forced to divest its wireless division to cope with its significant debt burden. Even though spectrum payments are seen as “sunk costs” that should not affect subsequent pricing and investment decisions, this ignores the effect that these payments had on the financial ability of mobile operators and on their subsequent ability to make investments. Detailed analyses of the precise impact of “spectrum overpayments” on the cost of capital for mobile operators are not available, but **Figure 6** shows that investment levels (capital intensity as a share of revenue) in Europe have been

⁴⁵ See Statement of Christian Michael Dippon (2009) (NERA Economic Consulting), “Regulatory Policy Goals and Spectrum Auction Design: Lessons from the Canadian AWS Auction”, Prepared for Telus Inc.



persistently lower in Europe than North America for the better part of a decade. After the irrational exuberance of the auctions of the early 2000s, the European industry has been characterised by significant caution. For example, in the recent German auctions of LTE spectrum, only the incumbent operators bid on the spectrum and the regulator made no effort to solicit further entry.

6.2. Unviable entry and resource waste

98. Given the industry background discussed previously, there is a high probability that many, or even most, new entrants will not be successful. In 2007, Industry Canada asked itself whether or not the prospects of unviable entry were a major risk associated with the set-aside, and convinced itself that “market forces” would correct for this risk. Presumably what they meant was that even if a firm failed, its assets and spectrum would eventually be acquired.⁴⁶
99. However, Industry Canada appears to neglect the possibility that even if the relevant resources are eventually reallocated, the process is not likely to be costless. In the U.S. PCS licensing of the mid-1990s (which did have a large set-aside), Hazlett and Boliek (1999) point out that 53% of set-aside licenses were eventually returned, an astonishing failure rate.⁴⁷ However, what is equally interesting is that between the time these licenses were returned and the time that they were eventually reallocated to firms that could use them, the total delay in utilising these licenses cost consumers \$5.4 billion.
100. The experience of Hutchison and other firms in Europe also suggests that financially weak firms may persist in business for longer than might be efficient. For instance, Hutchison’s persistence in European markets is remarkable given the cash it has lost so far, but the major constraint on its ability to exit the market by selling its assets might (ironically) be competition authorities who will see it as a “significant lessening of competition.” Even in cases where firms did not even begin to provide service, it took at least two to three years before their licenses were returned—this was the case with Mobilcom and Group 3G in Germany and Group 3G in Austria.
101. Allocating 40 percent of a block of spectrum (in the AWS auction) to a group of companies whose success is highly uncertain thus represented a major gamble by Industry Canada. The consequences of this gamble are amplified by the fact that Canada has less licensed spectrum than other countries and is seeing equivalently rapid growth in mobile data services. According to recent figures released by the Canadian Wireless Telecommunications Association (CWTA) there are some 5.6 million wireless broadband

⁴⁶ Indeed, Industry Canada stated: “Potential adverse impact (i.e. unviable entry) can be corrected by market forces should a new entrant fail. The risk of having the spectrum bought by all the incumbents is that the opportunity of having further competitive entry into the market would be prevented.” See Part II of *Consultation on a Framework to Auction Spectrum in the 2 GHz Range Including Advanced Wireless Services*.

⁴⁷ Boliek, Babbette E.L., and Thomas Hazlett, (1999), “Use of Designated Entity Preferences in Assigning Wireless Licenses”, 51, *Federal Communications Law Journal* (May 1999), pp.639-63.

subscribers in Canada now—i.e., those who have a voice and data plan for a smartphone, or who use wireless broadband dongles to get service.⁴⁸ Yankee Group data suggest that the number of data cards in circulation in Canada more than doubled between 2007 and 2009.⁴⁹ Rogers Wireless reports that some 41 percent of its post-paid subscribers are smartphone users.⁵⁰ There is consequently a real chance that some firms with genuine capability to expand innovative new services will suffer spectrum-related constraints, while other firms have vast amounts of spectrum relative to their short-term needs and will prove unviable in the long term. The associated resource misallocation might well cost consumers billions of dollars.

6.3. A continuing cost of set-asides in Canada

102. The set-aside used in the 2008 AWS auction significantly restricted the amount of spectrum that incumbent firms — firms that have an established record of being able to successfully deploy high-quality networks and serve large numbers of customers across Canada — were able to win. Thus the three incumbent firms were not separately able to win 20 MHz of spectrum in any province. This may represent a constraint on the future deployment plans of some of these firms.

103. Matters might be even more serious in 2012. Given that there will be a much more limited amount of spectrum available at the 700 MHz auction, it is difficult to see how Industry Canada can decide upon a set-aside that satisfies all the entrants that will want to see their entry “sustained” while offering enough spectrum to incumbents. For instance, even to have two separate incumbent LTE networks (Rogers and a joint Bell-Telus network, for example) that meaningfully utilise the 700 MHz spectrum in that deployment, 40 MHz of spectrum might be required for incumbents to win. If only 50 MHz or 60 MHz of spectrum are available, then Industry Canada might find itself in the awkward position of seeing some of the new entrants of 2008 not win any 700 MHz spectrum. It may find it easier to resolve the issue by deciding upon a larger set-aside and thus leaving only one incumbent LTE network that uses the 700 MHz spectrum. The loss of competition in this case would be truly meaningful and perhaps even permanently adversely alter the path of wireless broadband deployment in Canada. We can offer no comment on the probability of this, other than to note that affirmative policies can easily be misconstrued as the backing of a regulator for particular firms or sets of firms.

6.4. Social costs of entry

⁴⁸ Source: CWTA, http://www.cwta.ca/CWTASite/english/newsletter_070211.html#12.

⁴⁹ Source: Yankee Group.

⁵⁰ Source: www.cellular-news.com, “Rogers Communications Profits Drop on Higher Smartphone Subsidy Costs”, February 16th 2011. The same report suggests that Rogers activated 635,000 smartphones in the fourth quarter of 2010 alone.

104. The existence of hard bounds on the number of competitors in a wireless market inherently reduces the scope for further efficient entry. By this it is meant entry that can expand aggregate social surplus and market output to a sufficient extent that it makes up for the additional resources (capital, for example) used in achieving an additional set of network facilities. That wireless markets have seen entrants come and go, and that mergers and consolidation have been common, suggests that existing market configurations with three or four competitors represent the extent of competition that is consistent with these firms earning back at least the sunk costs that were involved in the deployment of their network facilities.
105. Inevitably, entry into a mature market will involve higher unit average costs for existing firms (which lose scale) and reduce margins, thus creating strong incentives to restore the prior industry structure. For example, in the U.K. and Australia, the additional entry achieved in the early 2000s, has been reversed through existing industry participants merging with each other (the U.K.) or with the entrant (Australia) as a response to the pressures on their margins created by what was arguably too much entry.
106. A set-aside, or indeed a set-aside accompanied by caps and other “sweeteners”⁵¹ designed to promote entry might have an especial risk of inviting excessive entry, of which a fair proportion would inevitably be duplicative. This is likely to be the case because in reality a set-aside does not appear to be necessary in order for newcomers to acquire spectrum. Given that some entry is possible or even likely absent a set-aside, the set-aside simply extends an invitation to a wider range of would-be entrants. However, the firms for whom a set-aside is the governing factor determining whether they bid for spectrum or not are quite likely to be the firms with the least viability or the least capability to offer well-differentiated product offerings. In this sense, a set-aside invites excessive entry. Indeed, one sees an echo of this in Canada today, where entrants are focussing on serving urban areas where deployment costs are lowest and where the market is most likely to be saturated.⁵²
107. The wider economic literature indeed lends credence to the idea that there are dangers to inviting entry that might be simply duplicative of what is offered in the market today. Berry and Waldfogel (1999) offer a simple example for the case where products are perfect substitutes and all costs and prices are fixed. The entry of another firm that wins half the market share from the incumbent firm provides no increase in consumer benefit, although it increases the number of competitors. The problem is that twice the amount of

⁵¹ Such sweeteners might include favourable roaming and site-sharing arrangements, for instance.

⁵² This paragraph also speaks to the foreign ownership debate in Canadian telecoms. A large foreign firm might have advantageous access to new products, services and technologies, but such large foreign firms are more likely to enter the Canadian market via the acquisition of a well-established Canadian incumbent, rather than through Greenfield entry. Further, such large foreign firms are the least likely to need “sponsorship” from a regulatory agency, either in the form of spectrum set-asides or asymmetric restrictions on Canadian incumbents.

resource is used to provide the same level of output, thus reducing aggregate social welfare.⁵³

108. Of course, in the real world, costs and prices are not fixed. At the same time, the wireless market has the structure that it has because of the role of scale and scope economies, and sunk investments. In the short run even inefficient entry is likely to lead to a reduction of prices, benefiting consumers, but in the long run, such entry might not be beneficial. There are two reasons for this. First, if the reduction in scale of the incumbents raises their costs, entry might *raise incumbent prices*. Second, to the extent that aggressive pricing places pressure on overall industry margins, in the long run prices (and market structure) will tend to revert to their prior state as firms either leave the market or merge with each other. In the long run, firms need to earn returns sufficient to compensate for the fixed and sunk cost risked. There is in addition the consumer harm that is caused by restricting the availability of spectrum to potentially efficient firms, which has as its effect both raising prices and reducing consumer choice and the availability of the latest products, especially when one looks beyond the short-run.
109. In summary, a set-aside or similar policy in the Canadian wireless market runs a substantially higher risk of misallocating a precious resource than it does of promoting viable welfare-improving entry/expansion. The (gross) benefits of such a policy are likely to be small, and the costs substantially higher.
110. What is true of set-asides is also true of spectrum aggregation limits or spectrum caps, but caps pose some particular institutional issues that are worth some discussion.

6.5. Spectrum caps

111. Spectrum caps were widely used in the United States and Canada in the 1990s and early 2000s. The initial goal was to ensure that there would be a minimal level of competition in provision of services. For instance, the United States' spectrum cap was set at 45 MHz of licensed spectrum. At the time, there was typically 180 MHz of licensed spectrum in each "economic area" that was used for cellular licensing purposes. Thus the cap ensured that there would be at least four competitors. Eventually, the United States relaxed the cap requirement as the market matured. Canada too relaxed its own cap in 2004, which had been set at 55 MHz of licensed spectrum:

⁵³ Berry and Waldfoegel (1999) found that in the radio broadcasting industry "free entry" (that is the absence of any restriction on the number of market participants) reduced welfare by an amount equivalent to 45 percent of industry revenue. This welfare loss arose in the form of higher costs to radio broadcasters and to advertisers. See Berry, Steven T. and Joel Waldfoegel (1999), "Free Entry and Social Inefficiency in Radio Broadcasting", *RAND Journal of Economics*, 30, pp.397-420. See also, Mankiw, N. Gregory and Michael D. Whinston (1986), "Free Entry and Social Inefficiency", *RAND Journal of Economics*, 17, pp.48-58.

*The mobile spectrum cap policy was introduced in 1995 to encourage innovation and help new entrants become established in the wireless industry. Canada now has close to 14 million cell phone subscribers and a modern wireless infrastructure capable of delivering a wide range of voice, data and media services. The Canadian Radio-television and Telecommunications Commission (CRTC) provides an overview of the telecommunications market in its report to the government, *Status of Competition in Canadian Telecommunications Markets, 2003*. The CRTC report depicts a mobile market with strong growth relative to other telecommunications markets.⁵⁴*

112. Note that 2004 was the year in which Rogers purchased Microcell, which had emerged from bankruptcy proceedings. There is no evidence to suggest that since the cap was rescinded that the Canadian wireless industry has ceased to perform well. As mentioned previously, the wireless arms of the three major firms have invested a cumulative sum of over \$10 billion in their wireless networks between 2004 and 2009, and there are approaching 6 million broadband wireless subscriptions in Canada. The Competition Bureau in commenting on the Rogers/Microcell case said that it would not expect further facilities-based entry and also said that the history of competition between Bell, Telus and Rogers was reassuring:

Evidence suggested that the majority of competitive price reactions by a competitor in the mobile telecommunications market were prompted by the actions taken by Rogers, Bell or Telus, as opposed to actions taken by Microcell. This conclusion is reinforced by the nature of competition between these competitors in other telecommunications and broadcast distribution markets.⁵⁵

113. At a very basic level, then, if there was no need for a spectrum cap in 2004, then there is no need for a spectrum cap today. In order to conclude that there is, Industry Canada would need to demonstrate—via a systematic analysis of competition and market power—that the conclusions that it reached in 2004 and that the Competition Bureau reached that same year are no longer valid. Of course, Industry Canada or even the Bureau might claim that the approval of a merger is not in itself a finding of whether or not a firm possesses market power. We would agree in the Rogers/Microcell instance that the relevant issue being adjudicated was whether or not the acquisition of Microcell by Rogers substantially lessened competition, not whether Bell, Rogers or Telus individually or collectively had market power.

⁵⁴ Source: “Industry Minister Removes Limits on Spectrum Holdings for Cell Phone Companies”, August 27th, 2004, available at <http://www.ic.gc.ca/eic/site/ic1.nsf/eng/02374.html>.

⁵⁵ Source: “Acquisition of Microcell Telecommunications Inc. by Rogers Wireless Communications Inc.” Technical Backgrounder, Competition Bureau Canada, April 2005: <http://www.competitionbureau.gc.ca/eic/site/cb-bc.nsf/eng/00257.html#10>

114. But it would be disingenuous to ignore the background against which both the removal of the spectrum cap and the Rogers/Microcell merger occurred. The Microcell episode would appear to reveal that there was not enough room in the Canadian wireless market for a fourth profitable competitor.
115. This, taken in conjunction with the fact that the Bureau explicitly stated that further facilities-based entry was highly unlikely strongly suggest that given what they had observed to date, *neither industry participants nor their regulators would have expected anything other than a market characterised by competition between three firms for the foreseeable future*. Industry Canada did not remove the spectrum cap, nor did the Bureau approve the Rogers/Microcell transaction, with any expectation that the problematic aspects of a three-firm industry would be rectified by further entry. Rather, the evidence suggests that a three-firm industry was not seen as problematic. Further, these three roughly equal incumbents would have had roughly equal spectrum acquisition abilities, making it unlikely that any one firm would be able to use spectrum aggregation to constrain the ability of its rivals to expand.
116. In fact, as the analysis in Section 3 shows, the facts surrounding market performance in Canada are very favourable. Canada has become a leader in the deployment of wireless broadband networks, for instance, something that was not the case in 2004. Other indicia of output and pricing have moved in the right direction as well. If a cap was not a suitable policy for the Canadian wireless market of 2004, it surely is not so today. The main reason we may be debating spectrum caps today is because Industry Canada's policies resulted in too much entry in 2008 and it now worries about "sustaining" that entry.⁵⁶
117. There is also an inherent "design" problem associated with spectrum caps, one that should carry particular weight in the current wireless environment. Designers of spectrum aggregation limits by definition will need to conclude (a) how much spectrum is "enough", and (b) the degree to which spectrum holdings across different bands are perfect substitutes. Making strong conclusions about how much is "too much" or "just enough" would seem particularly foolhardy at a time when the wireless industry is characterised by rapid, but inherently uncertain, projected growth rates for data traffic. Thus one can be reasonably sure that mobile data traffic will double, treble, quadruple or even increase eight-fold over the next five years. However, will the increase in traffic be 32-fold or 16-fold? To such questions, few can know the answer. While it is possible that one can set a spectrum aggregation limit that ends up comfortably meeting the requirements of any and all carriers over the next few years, it is equally possible that one cannot.
118. For example, in the United States, the FCC has a screening level of 95 MHz in a given economic area, across all spectrum bands. Additions to holdings beyond this level are potentially flagged and might be challenged, although this would happen on a case-by-case basis under the current system. However, imagine if there were a spectrum cap that was set at a level close to this level—such was suggested by the Rural

⁵⁶ See Industry Canada Consultation Document at p.38.



Telecommunications Group and other interveners in 2008, who proposed a 110 MHz nation-wide cap.⁵⁷ The FCC's National Broadband Plan, while non-committal on the precise numbers, suggests that the amount of spectrum required per operator ranges from 40 MHz to 150 MHz. However, Clearwire states that 120 MHz of contiguous spectrum is required for true mobile broadband. Other sources have claimed that 100 MHz of spectrum is required for mobile broadband backhaul alone.⁵⁸ While each of these individual numbers is disputable, they all suggest that a cap of 110 MHz would run a rather high risk of soon being hit.⁵⁹ As was very well put by Haring *et al* (2001), in an early study of the effects of spectrum caps, “a hat that fits an infant is unlikely to continue to fit the child as the child grows.”⁶⁰

119. Leighton (2009) provides a simulation analysis to illustrate the effect that aggregation limits can have in a dynamic market—the damage caused by an ill-fitting cap. In his analysis, he models the impact on investment costs if limitations were placed on the size of spectrum blocks that firms were allowed to acquire to expand their services. Thus, a firm that is operating near its spectrum aggregation limit may find it optimal on an engineering and economic basis to meet present and anticipated future demand by expanding via the acquisition of a 2x20 MHz block of spectrum. But if the spectrum aggregation limit instead makes it only permissible to expand by acquiring 2x5 MHz blocks, investment costs might be doubled or even quadrupled, with a concomitant effect on prices.⁶¹

120. Secondly, there is a particular issue with the idea of a cap on aggregate spectrum that does not recognise the particularly imperfect substitutability of different spectrum bands in the Canadian wireless market. An aggregate spectrum cap might treat 1 MHz of spectrum in the 2500 MHz band as identical to 1 MHz in the 700 MHz band, when they are not identical from a deployment cost perspective, and not identical in terms of the uses that they can sustain. In Canada, their substitutability is further limited by the fact that the Canadian wireless operators are rather small by global standards (Table 3). This

⁵⁷ Rural Telecommunications Group, Inc., *In the Matter of Rural Telecommunications Group, Inc. Petition for Rulemaking To Impose a Spectrum Aggregation Limit on all Commercial Terrestrial Wireless Spectrum Below 2.3 GHz*, Petition for Rulemaking, filed July 16, 2008.

⁵⁸ See endnote 65 to Chapter 5 of FCC's National Broadband Plan. http://www.broadband.gov/plan/5-spectrum/#_edn65.

⁵⁹ Of course, capital expenditure is a substitute for spectrum, but when we refer to operators requiring more spectrum, we mean that the economically efficient way for that operator to expand would be via acquiring more spectrum rather than continuing to invest in network assets.

⁶⁰ Haring John, Harry M. Shooshan and Kirsten M. Pehrsson (2001), “White Paper on Elimination of the Spectrum Cap”, Strategic Policy Research Report.

⁶¹ Leighton, Wayne A. (2009), “Measuring the Effects of Spectrum Aggregation Limits: Three Case Studies from Latin America”, Francisco Marroquin University, available at <http://ssrn.com/abstract=1494371>.



in itself means that Canadian wireless operators, even the biggest ones, must synchronise their deployment bands with foreign, particularly American, wireless operators in order to attract a sufficient ecosystem of handsets, applications and services to Canada.

121. Thus if a cap results in some incumbent firms not being able to use 700 MHz spectrum to deploy LTE, for instance, this would have serious consequences for strong competition in LTE-based services in Canada, as these efficient and competitive firms might be left with inferior alternatives for their deployment. It would be unwise to assume that the competitive slack would be taken up by entrants, given that the incumbent firms are precisely the ones that have proven themselves most capable of deploying and managing networks across wide areas of the country, while the entrants are unproven in this regard. Further, it is all but inevitable that any suggestion of revising a cap would be subject to significant lobbying and the delays associated with a rule-making process. While this could happen even under a system of case-by-case review, revising a cap would have the same institutional difficulties as revising any codified rule or law carries with it. This, in turn, will tend to cut against the efficient functioning of secondary spectrum markets: for example, if caps are in place, this may put Rogers, Bell and Telus out of the secondary market altogether, and leave them reliant on petitions or periodic reviews to seek revisions to their cap. The effect of such a policy would be to constrain the expansion of highly efficient and successful businesses. As with the analysis of a set-aside, even if this “benefits” competitors to these firms, it is a business-stealing effect that is at work and overall welfare will be reduced.
122. Finally, we turn to a discussion of another issue, one that is distinct from set-asides and caps, but which also suggests that Industry Canada’s spectrum policies betray some confusion between competition and particular competitors. This issue is one of how “incumbents” and “entrants” were defined in the first place.

7. MARKET DEFINITION: WHO IS AN ENTRANT AND WHO IS AN INCUMBENT?

123. A major issue with the conduct of the 2008 AWS auction was the definition of an entrant as a firm with less than a certain share of the national market. This definition simply fails to accord with accepted definitions of the relevant geographic market in North American wireless markets. In 2004, the Competition Bureau ruled that the relevant geographic markets in Canada were provincial. The FCC in the United States has consistently ruled that the relevant geographic market for wireless services is at the level of Cellular Market Areas (CMAs) or Component Economic Areas (CEAs) that are certainly sub-national.⁶²

⁶² See for example the discussion in Connolly, Michelle and Jamie Prieger, “Economics at the FCC: Broadband and Merger Review”, *Review of Industrial Organization*, Volume 35, No. 4 (2009), at pp. 387-417.

124. In practice, a discussion of national markets and national market shares is permissible when there is little variation in the level of competition and the nature and identity of competitors across regional markets. Thus when we look at international evidence, we can devise a concept such as the “Canadian market” that we can compare to, say, the “Italian market”, because for the substantial majority of Canadians, there is a typical menu of choices, just as there is for Italians. The inclusion of the United States in such statistics is a little more problematic because the United States has more substantial variations, but even there on a population-weighted basis, there are four national firms that are typically available to Americans, plus perhaps the choice of one or more regional firms. In any case, these comparative discussions might shed useful light on key aspects of market structure, but they do not constitute the basis for assessing market power.
125. However, concerns about spectrum aggregation are concerns about market power. When assessing market power related to spectrum aggregation, there is no national market in Canada. Licensing of spectrum is inherently provincial or sub-provincial. This means that spectrum-related barriers to entry are at the regional level, not the national level. A firm that has the entire spectrum in Ontario cannot constrain prices in Manitoba if it has no spectrum in Manitoba.
126. This issue has been compounded by Industry Canada’s AWS policies. In that instance, the set-aside itself has created spectrum-related barriers to entry at the regional level. In Quebec, for example, Videotron successfully blocked all other entrants from obtaining spectrum in that market. One firm now has 40% of the AWS spectrum that it won in a “protected” setting, and as a result both entrant firms and possibly one incumbent firm have been precluded from the chance to offer LTE services over their separate network in Quebec using the AWS spectrum.
127. The market shares to which Industry Canada refers are *output* market shares in the *national* market. This creates a serious disconnect between its spectrum licensing policies at the *regional* and *provincial* levels, and its set-aside policy. In the only market that it intends to serve with its own network, Videotron has no spectrum constraints for the foreseeable future, while competition from other firms has been constrained.⁶³ Yet persisting with the market definition that Industry Canada used in 2008, and indeed applying it not just to a set-aside but to a spectrum cap, would continue to allow Videotron to obtain spectrum in ways that potentially restrict the choices available to Quebec customers. The only possible beneficiaries in this case are Videotron’s owners, and not Quebec customers.
128. Similarly, regional incumbent firms such as MTS have overwhelming market share in their “home” region. Dippon (2009) presents data showing that in Manitoba and Saskatchewan, the national incumbents had only 39% and 19% market share as of 2006. Yet they were precluded from bidding on the set-aside spectrum in Manitoba and Saskatchewan, even though if there were any regional markets in Canada where the competitive conditions justified a set-aside, it would be Manitoba and Saskatchewan.

⁶³ This constraint on competition from other firms might arise because the incumbent firms were unable to each win 20 MHz of AWS spectrum in each province.

129. Dippon (2009) contains the following quote from MTS:

As a result of the AWS spectrum auction, two new entrants became the provisional licensees for sufficient spectrum in Manitoba to enable them to offer wireless services in competition with us. These new entrants have indicated publicly that they will initially focus their efforts on more densely populated areas of Canada where they also acquired spectrum, and one announced that it will delay entry into our market in Manitoba. We are well-positioned to face these new competitors, and there is no certainty that these new entrants will create a more competitive environment in Manitoba at some point in the future.⁶⁴

130. MTS' statement illustrates two things. First, it illustrates that there are important regional dynamics to competition in the Canadian wireless market. Second, it also illustrates the precise nature of much of the entry that Industry Canada's policies have invited. That entry is concentrated on serving the markets that already have the highest penetration and which are characterised by the most favourable demographic and cost characteristics, while leaving untouched the regional markets that arguably had the most room to benefit from entry.⁶⁵

131. A final twist in the tale is that, as noted, spectrum is merely an input, not an output. In the limit, one can imagine that a firm has 50% or more of the spectrum in a province but minimal market share, and that it continues to acquire a higher share of spectrum because of set-aside and cap policies. This would represent a substantial waste of resources and likely a substantial reduction in competition and investment at the provincial level.

132. Further it might even encourage speculative entry, wherein firms with backing from hedge funds or private equity groups find that they can acquire large amounts of spectrum, exercise a "wait" option to judge their market prospects before investing in actual network assets, and then if conditions are not favourable, exit the market and sell their spectrum to another firm at a potentially much higher price (with spectrum caps and set-asides helping to create spectrum scarcities for other firms, and thus driving up the value of existing spectrum holdings). Lest this scenario sound far-fetched, consider the fact that a firm like Harbinger Capital, a private equity group, has acquired a very large amount of Mobile Satellite Spectrum (MSS) in the United States. There is still uncertainty about Harbinger's true intentions, although it has announced that it intends to deploy a nationwide 4G network.

⁶⁴ As cited in Dippon, p.40.

⁶⁵ The point here is more about what MTS' apparently relaxed statements say about the nature of the entry that Industry Canada incited than a direct criticism of how it defined "incumbents" and "entrants."

8. SOME BRIEF CONCLUDING THOUGHTS

133. Economic theory has a general rule to answer the question of how a scarce and valuable resource such as spectrum can be optimally distributed: the firms that value the spectrum most should be the firms that get the spectrum. In this paper, we have acknowledged that there are potential violations of this rule. But we have also shown that there is little evidence that the rule is actually being violated in the Canadian wireless market.
134. Throughout this paper, we have shown that foreclosure of entrants from acquiring spectrum is over-emphasised, and that the real-world context of the wireless industry suggests that foreclosure is unlikely. As we discuss extensively, the natural concentration of wireless markets means that rational incumbent firms would have substantial uncertainty about the prospects of new entrants, and this would reduce their incentives to pre-empt these entrant firms from acquiring spectrum. This same “natural” concentration also speaks to the limited desirability of new entry, as it implies that there is a high chance of unviable entry or inefficient entry (or both). To the extent that a set-aside or other affirmative spectrum policies incent further such entry, they are economically damaging.
135. The economic damage that they inflict arises in several ways. They raise, needlessly, the cost of acquiring spectrum for efficient incumbent firms, while also constraining the ability of these firms to expand (as was the case with the 2008 AWS auction, which substantially curtailed the ability of Bell and Telus to offer separate LTE networks using the AWS spectrum). They divert a valuable and scarce resource from efficient “tried and tested” firms to firms with a high probability of failure, and thus incur a high likelihood of simply wasting the resource at a time when the resource is likely to be especially critical. The inefficient excessive entry that they might induce also raises costs (and ultimately prices) for the industry as a whole.
136. Most fundamentally, neither Industry Canada nor any other agency has ever established that there is “insufficient competition” of the type that would be cured by further entry AND that such further entry could only happen or could only be “sustained” with a set-aside or by using spectrum aggregation limits.
137. We would like to offer the Canadian AWS auction as a final example to justify our belief that “pre-emption” or foreclosure is an overemphasised possibility.
138. The usual “proof” that a set-aside is required is a claim that incumbents “hoard” spectrum. For example, it has been alleged in a recent newspaper article that Bell, Telus and Rogers are “hoarding” AWS spectrum.⁶⁶ Of course, such spectrum was clearly purchased by North American incumbents with LTE deployments in mind. Further, if they did just purchase the spectrum to “hoard it”, then the results of the Canadian AWS auction are truly inexplicable.

⁶⁶ Nowak, Peter, “Telecom: Handicapped by Handsets”, *Canadian Business*, February 14th, 2011.



139. In that auction, the set-aside of 40 MHz of spectrum guaranteed that there would either be one “entrant” with a huge chunk of the scarce resource, or that there would be multiple entrants. Thus entry was guaranteed by the auction rules. Despite this, the Canadian incumbents paid three times the predicted price (Dippon 2009) on the unrestricted spectrum. Did it make sense for Bell to pay over \$700 million to acquire 10 MHz to 20 MHz of spectrum simply to prevent the “entrants” from acquiring that spectrum? If it did so, then this can only reflect the incremental profit threat posed by one or two entrants acquiring 10 MHz to 20 MHz of additional spectrum on top of what they already had. For instance, given Videotron had already acquired 40 MHz of AWS spectrum in Quebec, Bell’s payments in Quebec simply reflect the pre-emption premium for just the additional 10 MHz of spectrum that Videotron could potentially have acquired. This does not stand to reason. The additional 10 MHz to 20 MHz of spectrum that could have been acquired by new entrants would simply not have translated into the type of profit threat implied by the AWS payments.⁶⁷ This is especially true considering the amount of time it is likely to take Videotron to “fill up” the 40 MHz it already has. In reality, the reason that incumbents paid as much as they did simply reflected the scarcity of spectrum made available to them.
140. At a time when medium-term spectrum scarcities seem quite possible, it would be unwise to make the assumption that spectrum will be more productively used by unproven entrants than by proven incumbents, especially given that the major driver of spectrum demand—growth in data traffic—will largely play out on incumbent networks. Public policies such as set-asides and spectrum caps that consciously reduce the availability of an input—700 MHz spectrum—that is crucial to the North American mobile broadband ecosystem to those in a position to best utilise that input is not in the best interest of Canada and Canadians. Instead, what is required is a hard-headed recognition of the substantial limits to how much more competition can be achieved and the substantial costs of misallocating the scarce spectrum resource in the name of possibly futile competition. In this paper, it has been our goal to highlight this real trade-off, and we hope that our analysis sparks a debate along these lines.
141. Finally, we would like to end with a reminder that Canada has around 265 MHz of spectrum (licensed for mobile usage) available, compared to 589 in Norway and 593 in the United States.⁶⁸ Canada is also four years behind the United States in auctioning off 700 MHz spectrum. Where the U.S.’ National Broadband Plan has committed to finding and releasing 500 MHz of additional spectrum over the next few years, Canada’s Digital Economy strategy merely mentions that there will be auctions of 700 MHz and 2500 MHz spectrum within the next five years. Of course, Canada’s spectrum needs are not identical to those of the United States or any other country. But Canada is certainly not

⁶⁷ Of course, Bell also competed with Telus and Rogers to acquire spectrum. But for Bell to want to “pre-empt” Telus or Rogers, it would have to assume away the possibility that they too would want to just “hoard” the spectrum.

⁶⁸ Source: “Mobile Broadband in the Americas: Building Momentum in the AWS Band”, Global View Partners for GSM Association, www.gsmamobilebroadband.com/upload/resources/files/AWS.pdf.



ahead of the curve in spectrum allocation, and the issue is acquiring particular urgency because as with other countries, mobile data traffic in Canada is set to grow dramatically in the coming five years.



Tables and Figures

Table 1: Simulated Impact of a Two-Year Deployment Delay on Consumer Surplus
(assumes consumer surplus = annual revenues)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	NPV
Annual revenue (\$ mn)	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
	500	1,000	1,500	2,500	4,000	5,000	4,000	3,000	2,000	1,000	17,400
	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$	\$
	-	-	1,000	2,500	4,000	5,000	4,000	3,000	2,000	1,000	15,618

The second row represents a two-year delay in deployment of the hypothetical service. The difference in NPVs is the lost social surplus as a result of the delay.

Note: This allows for shifts in consumer preferences so that demand for the service catches up very fast despite the delay in launch. NPV calculated using a 6% social discount rate.



Table 2: A Cross-Sectional Snapshot of Competition

	Penetration Rate	HHI	Top 2 Share	Competitors
Australia	122	3400	72%	3
Canada	73	3060	66%	5
France	97	3310	77%	3
Germany	126	2790	67%	4
Greece	146	3630	72%	3
Italy	149	2900	69%	4
Japan	90	3590	77%	4
Netherlands	114	3830	77%	3
South Korea	102	3880	82%	3
Spain	118	3340	74%	4
Sweden	136	3280	75%	4
UK	130	2210	51%	5
USA	95	2380	62%	5

Source: Merrill Lynch Global Wireless Matrix, Q3 2010.

Note: HHI is a better indicator of competition than number of competitors as some fourth and fifth competitors are very marginal. “Penetration rate” is essentially “SIM Cards per 100 individuals.”

Table 3: Revenue, Market Caps and Customer Numbers

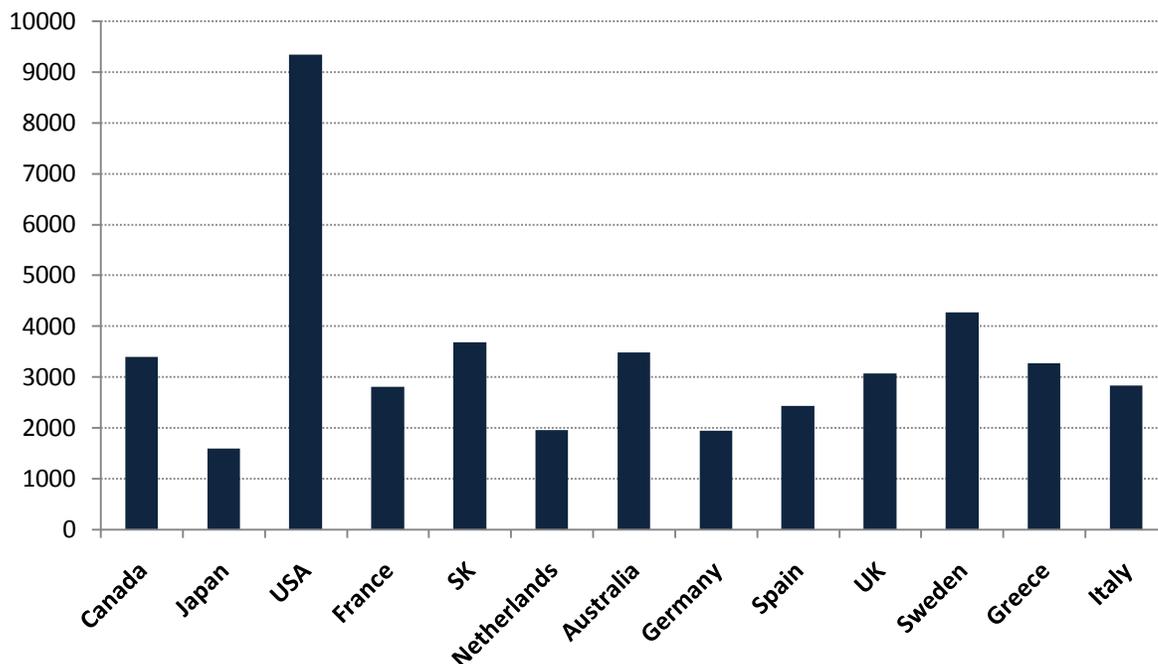
	Revenue (U.S. \$ bn)⁶⁹	Market Cap (U.S. \$ bn)	Total Accesses (m)⁷⁰
Vodafone	71	140	338
Telefonica	80	112	265
France Telecom/Orange	60	57	193
Deutsche Telekom	85	57	218
Verizon	107	102	135
AT&T	124	166	156
Bell Canada	18	27	17
Telus	10	15	12
Rogers	12	20	12

Source: Company reports, Telefonica Presentation, finance.yahoo.com.

⁶⁹ Vodafone: Y/E March 31st, 2010. Telefonica: Projected annual revenue based on first 9 months of 2010. FT/Orange: Based on first-half 2010 revenues. DT: Based on first 9 months of 2010.

⁷⁰ This is the sum of total fixed line (including business), broadband, wireless and Pay TV subscribers. Most of the data are from a Telefonica Presentation, February 2010, available at http://www.o2.com/downloads/profile_strategy_feb_2010.pdf.

Figure 1: Annual Minutes of Use per Capita (2010)



Source: (Annual MoU per subscriber) x (Subscribers per capita) based on Yankee Group and Merrill Lynch data. Note that other sources (e.g., Ofcom) adjust these data for presumed overstatement of minutes in RPP countries, but arrive at a fundamentally similar ranking.

Figure 2a: Growth in Canada’s Relative SIM-Card Penetration Rate

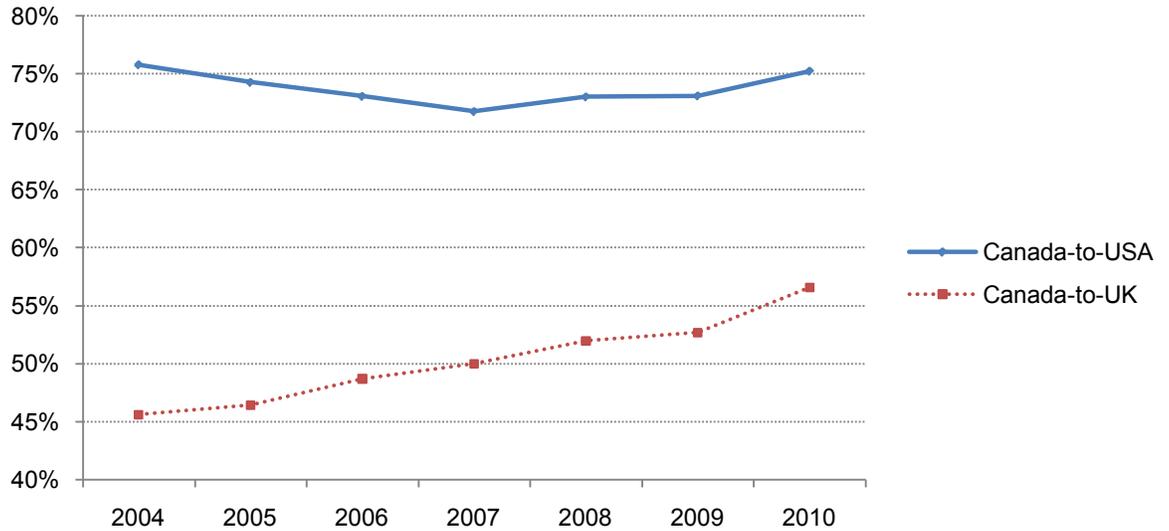
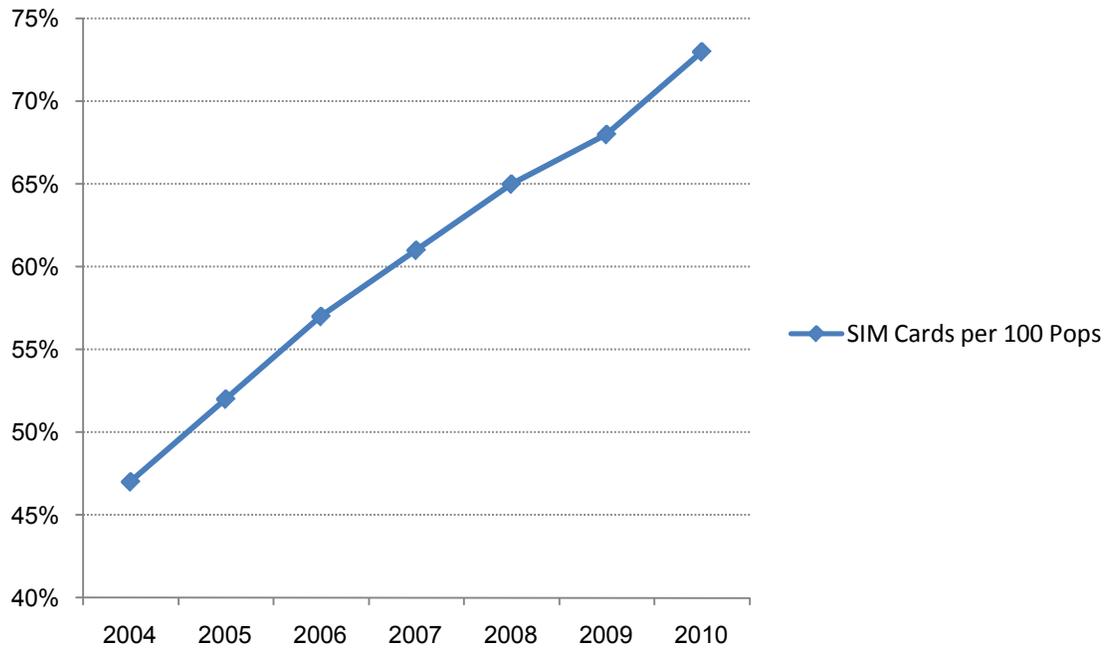
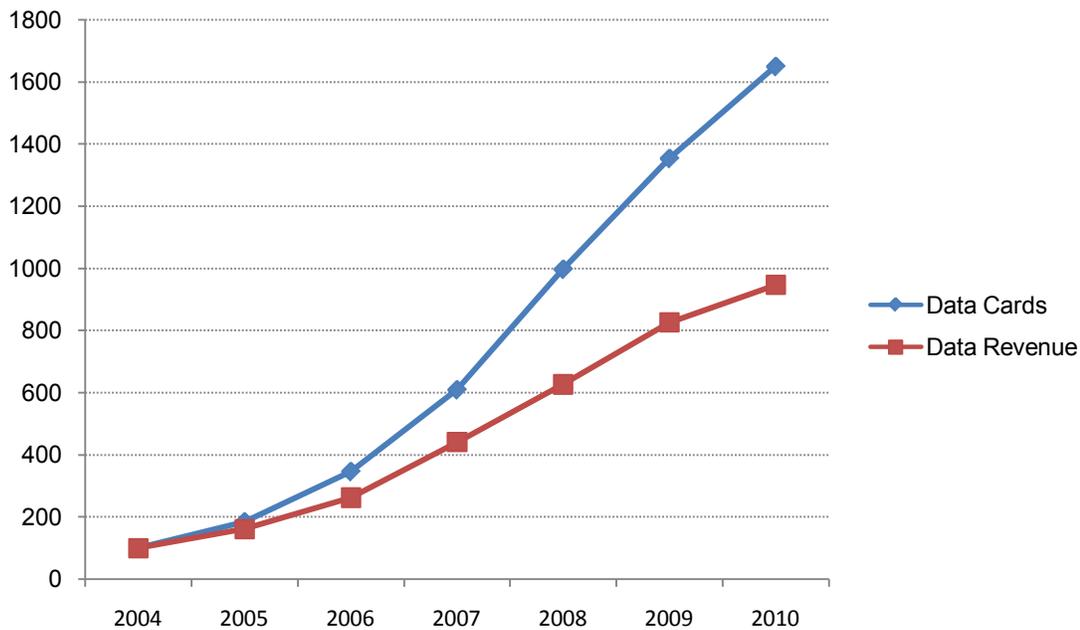


Figure 2b: Growth in Canada’s absolute SIM-Card Penetration Rate



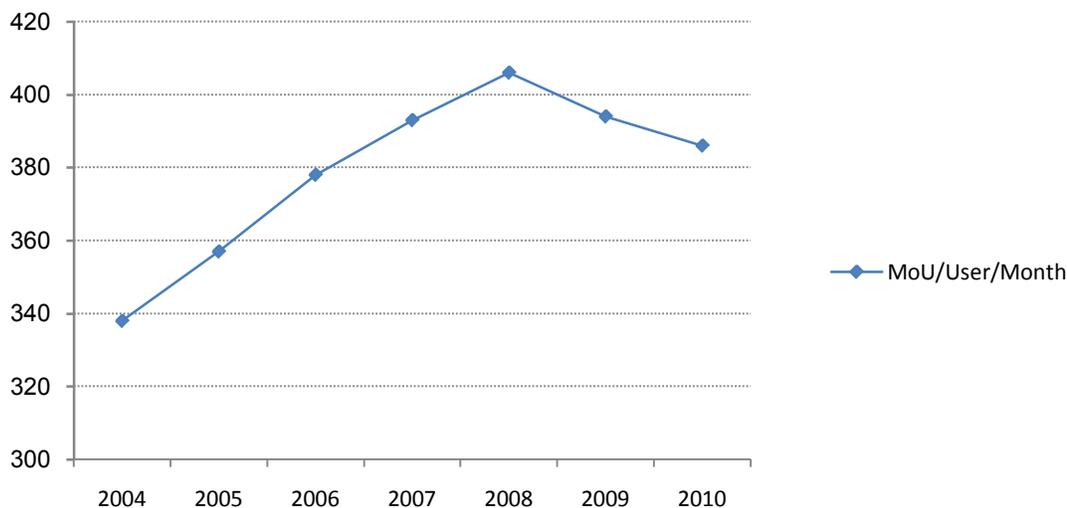
Source: Merrill Lynch Global Wireless Matrix, Q3 2010.

Figure 3: Data card and Data revenue growth (2004 = 100)



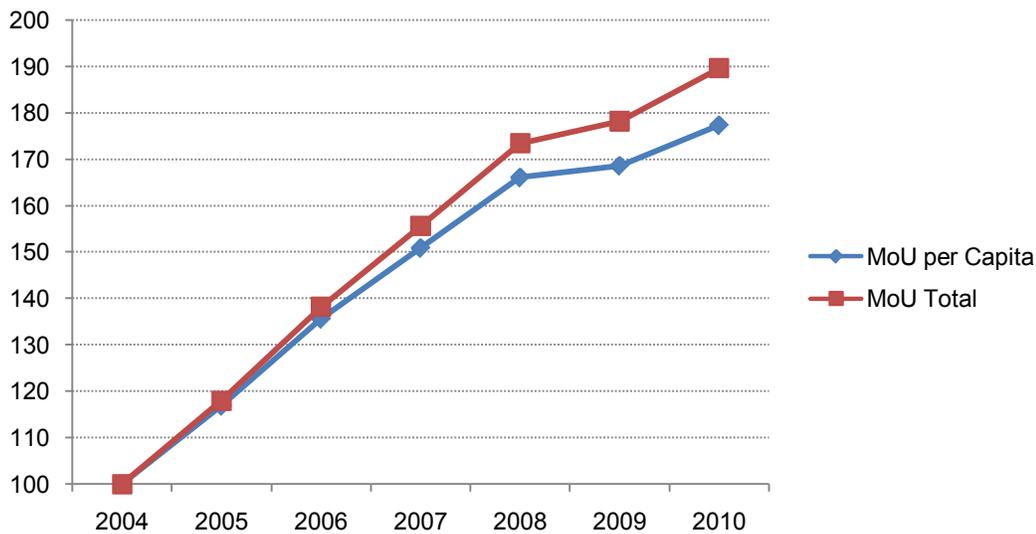
Source: Yankee Group, North American Mobile Forecast 2010.

Figure 4: Monthly Minutes of Use (Incoming and Outgoing) per Subscriber



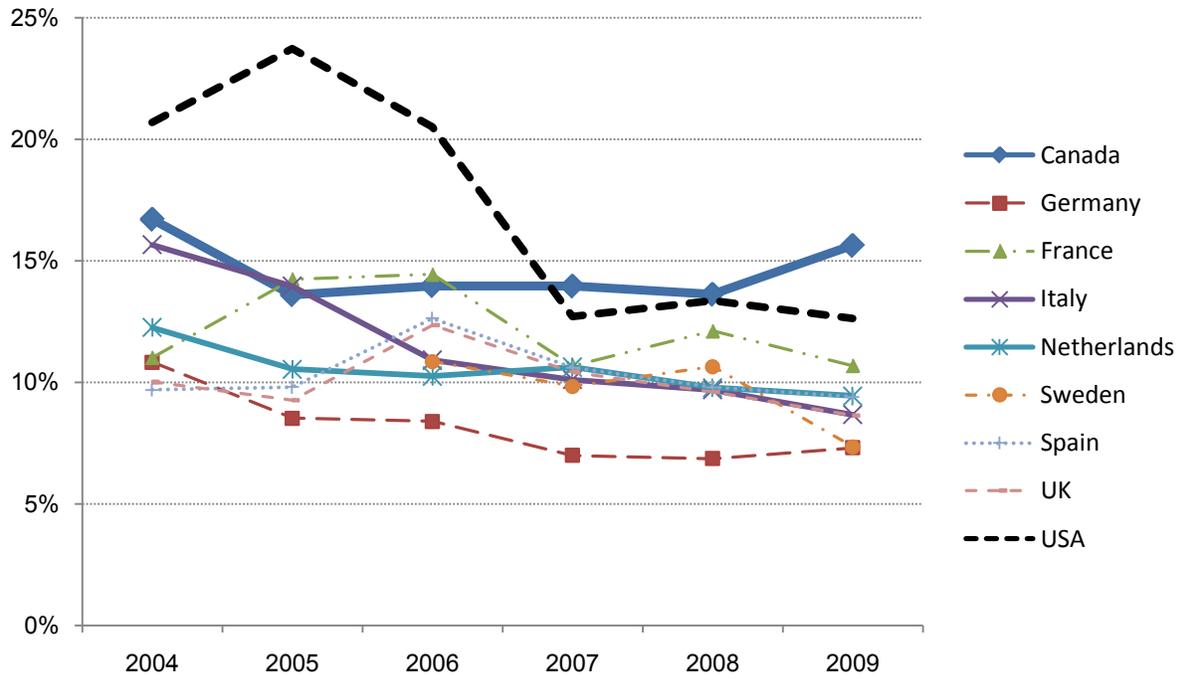
Source: Merrill Lynch GW Matrix, Q3 2010.

Figure 5: Growth in Aggregate and per-capita MoU (2004=100)



Source: BRG analysis based on ML data.

Figure 6: Capital expenditure as % of Revenues, 2004-2009



Source: BRG analysis of available country-level and operator-level data from ML Global Wireless Matrix.