Canadian Wireless Market Performance and the Potential Effect of an Additional Nationwide Carrier

PREPARED FOR

Competition Bureau

Government of Canada

PREPARED BY

Kevin C. Hearle
Giulia C. McHenry
James D. Reitzes
Jeremy Verlinda
Coleman Bazelon

May 12, 2014

THE Brattle GROUP

The Competition Bureau of the Government of Canada has engaged The Brattle Group to evaluate the competitiveness of the Canadian wireless market to provide evidence in relation to the Canadian Radio-television and Telecommunications Commission's (CRTC's) review of wholesale mobile wireless services in Telecom Notice of Consultation CRTC 2014-76.

We each acknowledge that it is our duty to provide evidence in relation to this proceeding as follows:

- to provide opinion evidence that is fair, objective and non-partisan;
- to provide opinion evidence that is related only to matters that are within our area of expertise; and,
- to provide such additional assistance as the Commission may reasonably require, to determine a matter in issue.

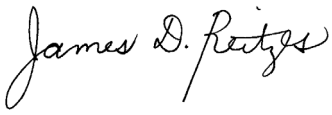
We each acknowledge that the duty referred to above prevails over any obligation which we may owe to any party by whom or on whose behalf we are engaged.

We acknowledge the valuable contributions of many individuals to this report and to the underlying analysis, including Maura Coughlin, Prateik Dalmia, Daniel Gaynor, Sarah Germain, Yonah Meiselman, and Ann Murray.

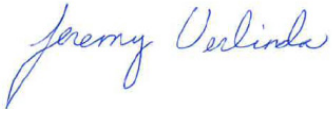
Finally, all results and any errors are our responsibility and do not necessarily represent the opinion of The Brattle Group, Inc. or its clients.

Kevin C. Hearle

Giulia C. McHenry



James D. Reitzes



Jeremy Verlinda

Coleman Bazelon

Dated May 12, 2014

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I. Introduction

We have been asked by the Canadian Competition Bureau to evaluate the competitiveness of the Canadian wireless "market".[1] The competitiveness of any market, but especially the competitiveness of a wireless market, is a complicated issue.

Recent studies by Jeffrey Church and Andrew Wilkins[2] (C&W 2013), Navigant Economics[3] (Navigant 2013), and others suggest that there is limited opportunity to further enhance competition in the Canadian wireless sector, particularly through entry of additional carriers. Moreover, certain policies proposed to enhance competition may actually harm consumers or be infeasible due to the lack of a profit opportunity awaiting potential entrants.

We first assess existing market power in the Canadian wireless sector based on wireless performance metrics and the potential profitability of wireless carriers in Canada. To expand our analysis, we estimate the competitive impact on prices and consumer surplus from the introduction of an additional nationwide carrier. Our analyses build on previous research and also offer new approaches to evaluating the effect of additional competition on wireless customers and incumbent producers.

In short, we find that:

- Canadian wireless industry metrics suggest that additional competition would benefit consumers. Canadian wireless carriers are highly concentrated, especially at the province-level. At a nationwide level, cross-country comparisons, particularly with the United States, suggest the Canadian wireless sector is underperforming in several respects.
- TELUS and Rogers Communications' (Rogers) wireless businesses are generally earning above-normal returns on their investments, consistent with the exercise of market power. Pre-tax returns for TELUS' wireless business range from 11.6% to 16.8% through 2018 (versus pre-tax cost of capital of 12.2%) and 13.8% to 17.9% through 2030 (versus pre-tax cost of capital of 11.5%). After-tax returns

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1 For purposes of this report, we did not perform a formal product or geographic market analysis of mobile telephony services. Our use of the term "market" is not intended to convey a formal definition of the telecommunications market(s) in Canada.

2 Jeffrey Church, and Andrew Wilkins, "Wireless Competition in Canada: An Assessment," University of Calgary: The School of Public Policy Research Papers, Vol. 6, Issue 27, September 2013 (hereinafter "C&W 2013").

3 Erik Bohlin, Kevin W. Caves and Jeffrey A. Eisenach "Mobile Wireless Market Performance In Canada: Lessons from the EU and the US," Navigant Economics, 2013 (hereinafter "Navigant 2013").

for Rogers range from 11.2% through 2018 (versus post-tax cost of capital of 8.5%) to 12.7% through 2030 (versus post-tax cost of capital of 8.1%).

- Our analysis of stock price reactions suggests that entry by Verizon would have resulted in approximately an 8% drop in profits for each of the three incumbents, assuming there was a 50% likelihood of Verizon entry. We estimate that the cumulative effect of two Verizon announcements between August and September 2013, which together clarified that it would not enter the Canadian market, increased stock prices by 10% for Rogers, 5% for Bell Canada (Bell), and 11% for TELUS.
- Using these stock price effects, we predict that the entry of an additional nationwide carrier would increase consumer surplus in Canada by approximately $1 billion annually, which represents 5% of 2012 industry revenues. We estimate that an additional nationwide carrier would expand wireless penetration from 78% to 81%, and drive down incumbents' average prices by about 2%. Much of this increase in surplus is driven by a modest increase in market size due to increased penetration and additional brand value associated with a new entrant.
- Incorporating the potential loss in industry "variable profits", we still find total annual surplus gains of approximately $1 billion per year. The annual loss in total industry variable profits, including incumbent losses and entrant gains, would equal approximately 0.1% of Canada's 2012 annual wireless service revenues. This analysis, however, does not consider the entrant's investment cost to build a network, nor any additional cost imposed on incumbent wireless carriers if they have less access to spectrum as a result of entry by the new carrier.
- To understand these other costs, we separately estimate that the incumbent carriers could avoid constructing a modest number of cell sites through 2017 if they were able to deploy an additional 10 MHz of spectrum, as opposed to having an additional nationwide carrier emerge. We estimate that Rogers could avoid constructing roughly 750 cell sites, Bell could avoid constructing approximately 350 cell sites, and TELUS could avoid constructing approximately 290 cell sites. The savings through 2017 would amount to between $80 million and $200 million for each carrier in present value terms.

This report is organized as follows. In **Section II**, we provide an overview of the Canadian wireless industry and compare it to the wireless industries in other developed countries. To the extent that they are indicative of market performance, cross-country comparisons, particularly with the United States, suggest that consumer surplus could increase if there were another large carrier. Nevertheless, since it is difficult to compare the level of wireless competition and market structures across countries, we also look for evidence of market power in carriers' conduct and performance.

In **Section III**, we estimate Rogers' and TELUS' wireless segment profitability to assess Canadian wireless carrier performance.[4] We find that the financial returns on Rogers' and TELUS' wireless businesses are above the appropriate cost of capital and consistent with the presence of market power in Canada. Nevertheless, this evidence does not necessarily imply, in itself, that Canada would benefit from facilitating the emergence of an additional nationwide wireless carrier.

In **Section IV**, we investigate the potential competitive effects of an additional nationwide wireless carrier in Canada. We combine the results from three separate analyses to understand the potential effects of an additional nationwide carrier on wireless profits, market structure, consumer surplus, and incumbent costs.

In this section, we first look at the financial market response to announcements by Verizon in 2013 that it was initially considering entering the Canadian market and, subsequently, that it was no longer considering entry in the foreseeable future. The reactions of Rogers', TELUS', and Bell's stock prices to Verizon's announcements is a signal of what the market anticipated would be the loss in profitability to the incumbents if an additional nationwide carrier were to emerge.

Second, we use the profit effects implied by this Verizon "event study" as inputs into a market simulation model. This model predicts the effect on market prices, market shares, customer penetration, consumer surplus, and total surplus that would be associated with the emergence of an additional nationwide wireless carrier. The model we use is similar to models used by antitrust agencies to assess the impact of mergers and other changes in market structure.

Our third analysis in **Section IV** estimates the additional network infrastructure cost to existing carriers that arises from the emergence or entry of an additional nationwide carrier. The market simulation model does not explicitly consider whether entry could significantly affect the fixed costs of network buildout facing the emergent or incumbent wireless carriers. Providing mobile wireless services requires building capital-intensive networks that use a specific scarce resource: radio spectrum. The engineering of wireless networks and scarcity of wireless spectrum imply a trade-off between the benefits of increased competition and the higher costs resulting from individual carriers having less spectrum with which to build their networks. Our analysis attempts to quantify some of these added costs.

Lastly, in **Section V**, we offer some concluding thoughts and caveats. Appendices A through D provide further details of the analyses that we have performed.

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[4] We investigated the feasibility of conducting the same analysis for Bell Canada's Wireless segment. We found that Bell Canada's financial reports do not sufficiently break out financials for the wireless segment for multiple years.

II. Status of Canadian Wireless Industry

Canada has three large wireless carriers that are considered "nationwide" carriers: Rogers, TELUS, and Bell. Together, these three account for approximately 90% of Canadian wireless subscribers. The remaining 10% includes a small competitive "fringe" of new entrants and regional carriers.

Provision of wireless services is more concentrated at the province-level than it is at the nationwide level. While the Canadian Radio-television Telecommunications Commission (CRTC) has implemented several policies to encourage competition, the growth of regional carriers and new entrants so far has been limited.[5] The relatively high province-level concentration suggests that wireless consumers may benefit from a strong additional nationwide carrier.

To gain greater insight into the state of the Canadian wireless competition, several studies have compared wireless market structure and performance in Canada with those of other developed countries. The goals of these studies generally are to evaluate the relative performance of the Canadian wireless market and to draw conclusions regarding the competitiveness of the Canadian wireless market as a result.[6]

A more detailed analysis of the structural and performance metrics that underlie these studies, however, suggests other possible interpretations. These metrics could be consistent with competitive conditions or with the potential for significant exercises of market power.

On balance, it is difficult to compare the level of wireless competition and market structures across countries. Cross-country comparisons frequently do not control for demand and cost factors, such as differences in consumer preferences, network costs, and telecommunication policies, which are likely to affect wireless industry structure and performance. Moreover, the

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[5] For instance, in 2008, the AWS spectrum auctions set aside 40 MHz of spectrum for new entrants and regional carriers, enticing entrants to buy spectrum and build networks. See Industry Canada, "Policy Framework for the Auction for Spectrum Licenses for Advanced Wireless Services and other Spectrum in the 2 GHz Range," November 2007, pp. 5-6, available at: http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08833.html (last visited February 4, 2014). New entrants from the AWS auction have struggled to compete with the three large carriers or have chosen not to build a network. Nevertheless, new entrants have generally had lower service prices than the incumbents. As we discuss in the Summary (Section V), the publicly available data is insufficient to fully assess the price effects of these policies.

[6] See, for instance, C&W 2013 and Navigant 2013. In particular, C&W 2013 argues that the traditional international comparisons of ARPU and penetration are irrelevant to the state of competition in the Canadian wireless market. Instead, it points to Canada as a leader in wireless usage. (See C&W 2013, p. 4.) Navigant 2013 argues that Canada's wireless industry performance is "on par" with wireless performance in the United States. (See Navigant 2013, Abstract.)

competitiveness of the wireless markets in the "benchmark" countries has not been definitively analyzed. Being on par with other countries is only indicative of a competitive marketplace if those other countries are known to have competitive wireless sectors.

To the extent that they are indicative of market performance, cross-country comparisons, particularly with the United States, suggest that consumer surplus[7] could increase if there were another large carrier. Nevertheless, the potential benefits of additional competition in terms of lower prices and increased wireless penetration[8] would have to be weighed against the possibility of added network buildout costs for incumbent carriers if less spectrum were available to them.

A. Overview of Industry

As shown in Figure 1, Rogers, TELUS, and Bell together account for approximately 90% of all Canadian subscribers, where Rogers has a somewhat higher share than TELUS and Bell.[9] Their revenue shares are similarly divided, with Rogers representing 36% of revenue, and TELUS and Bell each representing 28% of revenues as of 2012. Established regional service providers serve 5% of all Canadian subscribers. The remaining 5% is comprised of new entrants from the 2008 AWS auction, which have had minimal success in acquiring subscribers so far,[10] despite their generally lower pricing.[11]

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7 In economics, consumer surplus is the sum of the difference between what each consumer is willing to pay and what each consumer actually pays for a good or service. This generally refers to the additional, or "excess", value that consumers place on a particular good or service, above what they pay for that good or service.

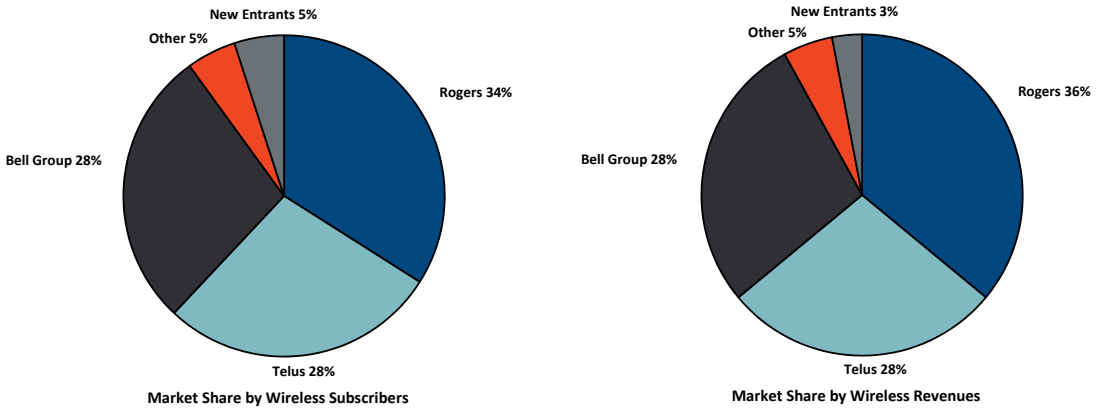
8 Wireless penetration represents the number of wireless subscriptions divided by population.

9 The Canadian wireless sector had $20.4 billion in revenues and 27.9 million subscribers in 2012, a 6.5% growth in revenue and 1.8% growth in subscribers over 2011. See CRTC, "Communications Monitoring Report," September 2013, (hereinafter "CRTC 2013"), p. iv.

10 The major exception is Quebecor, which has nearly 10% share in Quebec. Other new entrants include MTS Mobility, Videotron Mobile, Public Mobile, and DAVE Wireless. Several new entrants have had some success in building networks. In total, the new entrants' networks cover approximately 58% of the population. CRTC 2013, pp. iv and 161, Figures 5.5.4 and 5.5.5.

11 Wall Communications, Inc., "Price Comparisons of Wireline, Wireless and Internet Services in Canada and with Foreign Jurisdictions," 2013 (hereinafter "Wall 2013"), Table 3.

Figure 1. Canadian Wireless Market Share (2012)



Sources: CRTC 2013, p. 161, Figures 5.5.4 and 5.5.5.

Within the provinces, the provision of wireless service is highly concentrated. A standard tool for measuring concentration is the Herfindahl-Hirschman Index (HHI).[12] An HHI in excess of 2,500 is generally considered highly concentrated.[13] This HHI threshold is often associated with a rebuttable presumption that a significant increase in concentration could lead to higher consumer prices and a decrease in consumer surplus.[14]

As shown in Table 1, the HHI exceeds 2,500 in every province, and exceeds 3,333 in every province except Ontario and Quebec. Although Canada has three major incumbent carriers, they do not compete equally across all provinces. Bell and TELUS have relatively small subscriber shares in Manitoba and Saskatchewan, where regional providers, particularly

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12 The Herfindahl-Hirschman Index (HHI) is equal to the sum of the squared market shares of the individual competitors. The HHI is a common measure of market concentration used by antitrust authorities, including the Canadian Competition Bureau and the U.S. DOJ, to assist them in analyzing the competitive impacts of mergers. See, for example, the Competition Bureau of Canada, "Merger Enforcement Guidelines," October 2011, p. 19 (and n. 32). Also see the U.S. DOJ and Federal Trade Commission Horizontal Merger Guidelines, issued August 19, 2010 (hereinafter "U.S. HMG 2010"), available at http://www.ftc.gov/sites/default/files/attachments/merger-review/100819hmg.pdf.

The HHI runs on a scale of 0 to 10,000. In a monopoly market, the maximum HHI level is 10,000. When the market is comprised of N equal-sized firms the HHI level is 10,000/N. An HHI value of 10,000 indicates a perfectly monopolized market, while a market with three firms of equal market share would have an HHI value of 3,333.

13 U.S. HMG 2010, at 19.

14 *Id.* at 19.

Manitoba Wireless (MTS) in Manitoba and SaskTel in Saskatchewan, have over a 50% share and 70% share, respectively.[15]

Table 1 also illustrates the relatively high shares that are concentrated in just one or two firms within a province. The top firm has over 50% market share in all but three provinces, and the top two firms have a combined share in excess of 80% in all but four provinces. The average province-level share held by the top firm is 44%, while the top two firms have an average combined share of 73% across the provinces.[16] The top three firms hold a combined share of 90% or higher in every province, with an average province-level share of 94%.

The observed high concentration among just a few firms is largely a result of strong regional presences for MTS and SaskTel combined with *de facto* regional presences for Bell and TELUS. TELUS has greater subscriber shares in Alberta and British Columbia, while Bell has greater subscriber shares in the Eastern provinces.[17] Moreover, these two carriers have longstanding agreements in place to share a wireless network over large swaths of the country.[18] Overall, most provinces have one or two dominant carriers.

This nonuniformity of network coverage and subscriber shares across provinces leads to relatively high levels of province-level market concentration. This suggests that there is less competition at the province-level than the nationwide concentration metrics imply.

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[15] SaskTel and Manitoba Wireless (MTS Allstream) have large shares in their home markets but no significant share outside their home markets. SaskTel, 2012 Annual Report, p. 16; Manitoba Telecom Services, Inc., 2011 Annual Report, p. 10.

[16] The overall Canada average is calculated using a weighted average based on the number of subscribers in each province.

[17] See CRTC 2013, Table 5.5.5.

[18] See Barclays Equity Research, "Canadian Telecommunications & Media: Developed market with room for growth," November 2013 (hereinafter "Barclays 2013"), p. 41.

Table 1: Wireless Market Concentration by Province

Province	Share by Company					Combined Share of largest:			
	Rogers [1]	Bell [2]	TELUS [3]	AWS [4]	Other [5]	One Firm [6]	Two Firms [7]	Three Firms [8]	HHI [9]
Alberta	24%	23%	50%	3%	0%	50%	74%	97%	3,606
British Columbia	39%	18%	40%	3%	0%	40%	79%	97%	3,446
Manitoba	33%	5%	9%	0%	53%	53%	86%	95%	4,004
New Brunswick	19%	58%	23%	0%	0%	58%	81%	100%	4,254
Newfoundland and Labrador	2%	73%	25%	0%	0%	73%	98%	100%	5,958
Nova Scotia	16%	55%	29%	0%	0%	55%	84%	100%	4,095
Ontario	44%	28%	20%	6%	1%	44%	73%	93%	3,188
Prince Edward Island	15%	58%	27%	0%	0%	58%	85%	100%	4,318
Quebec	29%	33%	28%	10%	0%	33%	62%	90%	2,725
Saskatchewan	9%	10%	10%	0%	71%	71%	81%	91%	5,322
Canada	34%	28%	28%	5%	4%	44%	73%	94%	2,771

Notes:

[1]-[5]: Percent of total subsribers for Rogers, Bell Group, and TELUS, from CRTC 2013, Table 5.5.5.

[6]-[8]: Shares of 1, 2, and 3 larges companies in each province, from CRTC 2013, Table 5.5.5. It is assumed that shares labeled as "Other" in Manitoba and Saskatchewan are MTS Allstream and SaskTel, respectively.

[9]: Herfindahl index calculated as the sum of the squares of the shares of each carrier, from CRTC 2013, Table 5.5.5. For HHI calculation purposes only, we assume 3 equally sized AWS carriers in each province.

It is worth noting that Canada does have strong availability of wireless service. Nearly the entire Canadian population is covered by some wireless service. Approximately 99% of the total population is covered by HSPA+ (evolved high-speed packet access, or 3G), with each of the top three carriers reportedly covering more than 90% of the population.[19] Canadian carriers are also in the process of rapidly deploying LTE services. The CRTC reports that, as of the end of 2012, 72% of the population was covered by LTE (Long Term Evolution, or 4G) services, and deployment is continuing.[20]

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[19] CRTC 2013, p. 166, Table 5.5.10; TELUS, 2012 Annual Report, p. 22; Rogers, 2011 Annual Report, p. 26; and BCE, 2012 Annual Report, p. 27. Bell and TELUS claim to cover 97% of the population with HSPA+, while Rogers claims to cover 91% of the population.

[20] CRTC 2013, p. 166, Table 5.5.10. According to its website, Rogers expected to reach 68% of the population with LTE coverage by the end of 2013. (See "Rogers LTE Network: The New Speed of Life," Rogers, accessed January 21, 2014, http://www.rogers.com/web/content/wireless_network; and "Canada's Population Estimates, Third Quarter 2013," Statistics Canada, December 18, 2013.) As of August 2013, TELUS claimed to reach 80% LTE coverage. (See Hardy, Ian, "Telus Claims LTE Network Reaches About 80% of the Canadian Population, Expands Coverage in Ontario," MobileSyrup, August 13, 2013, accessed January 21, 2014, http://mobilesyrup.com/2013/08/13/telus-claims-lte-network-reaches-about-80-of-the-canadian-population-expands-coverage-in-ontario/.) At the same time, Bell claimed its LTE network covered about 73% of Canada's population. (See, Hardy, Ian, "Bell Q2 2013 Results: Subscriber Base Now at 7,715,641, ARPU $56.85 and LTE Network Reaches 73% of the Canadian Population," MobileSyrup, August 8, 2013, accessed January 21, 2014,

Continued on next page

Despite industry concentration, the majority of Canadians have at least some choice of wireless carrier. Approximately 57% of the population is covered by at least four carriers, and another 22% is covered by three carriers.[21] However, as discussed below, the competition created by having a choice of possible network providers has not translated to wireless penetration rates in Canada that are as high as many other developed countries.

B. International Wireless Performance Comparisons

Canada has a high average revenue per user (ARPU) and low service penetration levels in comparison to other developed countries.[22] As described in Figure 2 below, Canada's penetration rate was 79% in Q4 2012, 24% lower than the United States and other developed countries.[23] Figure 3 illustrates that Canada's ARPU is 17% higher than the United States and at least 21% higher than the developed European countries. On a purchasing power parity (PPP) basis,[24] Canada's ARPU is 6% lower than the United States, but at least 45% higher than other the developed European countries. There are several ways to interpret these, and related, metrics.

Continued from previous page

http://mobilesyrup.com/2013/08/08/bell-q2-2013-results-subscriber-base-now-at-7715641-arpu-56-85-and-lte-network-reaches-73-of-the-canadian-population/.)

21 CRTC 2013, p. 167, Table 5.5.11.

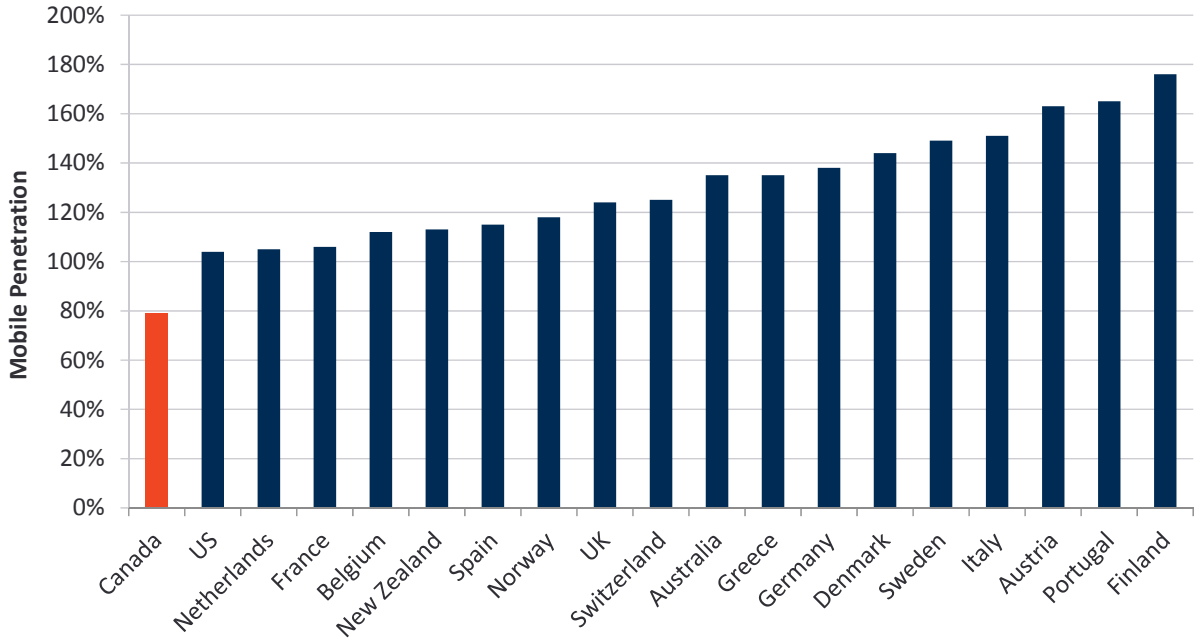
22 For the purposes of this analysis, we compare Canada to a collection of similarly developed countries mostly in Europe, as well as the United States, Australia and New Zealand. We follow C&W 2013's designation of "developed" European countries.

23 For most data presented, 2012 was the most recent data available.

24 The purchasing power parity (PPP) adjustment is based on the OECD index of PPP, and reflects the relative purchasing power of consumers in each country. The PPP index is a currency converter that adjusts for both exchange rates and the relative price of comparable goods across countries. For more details, see http://stats.oecd.org/Index.aspx?DataSetCode=PPPGDP (last visited February 26, 2014).

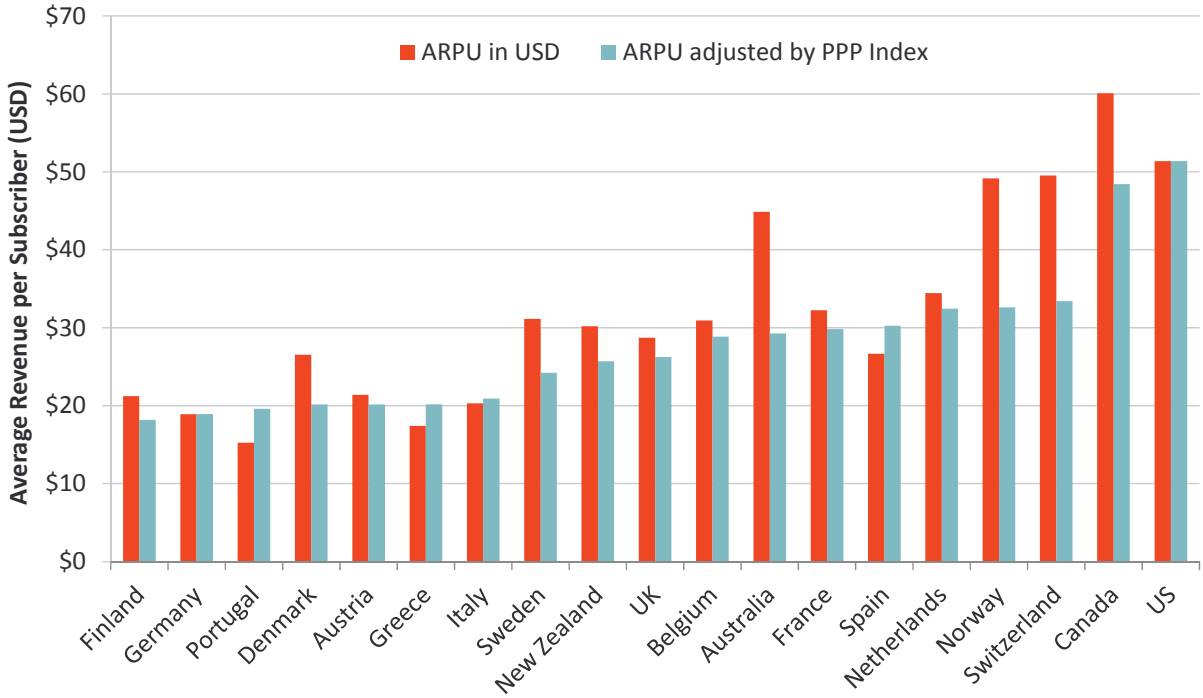
For the purposes of the exchange rate data, Figure 3 calculates the PPP relative to the USD.

Figure 2. Mobile Penetration by Country (2012)



Source: Global Wireless Matrix 1Q2013. Table 1.

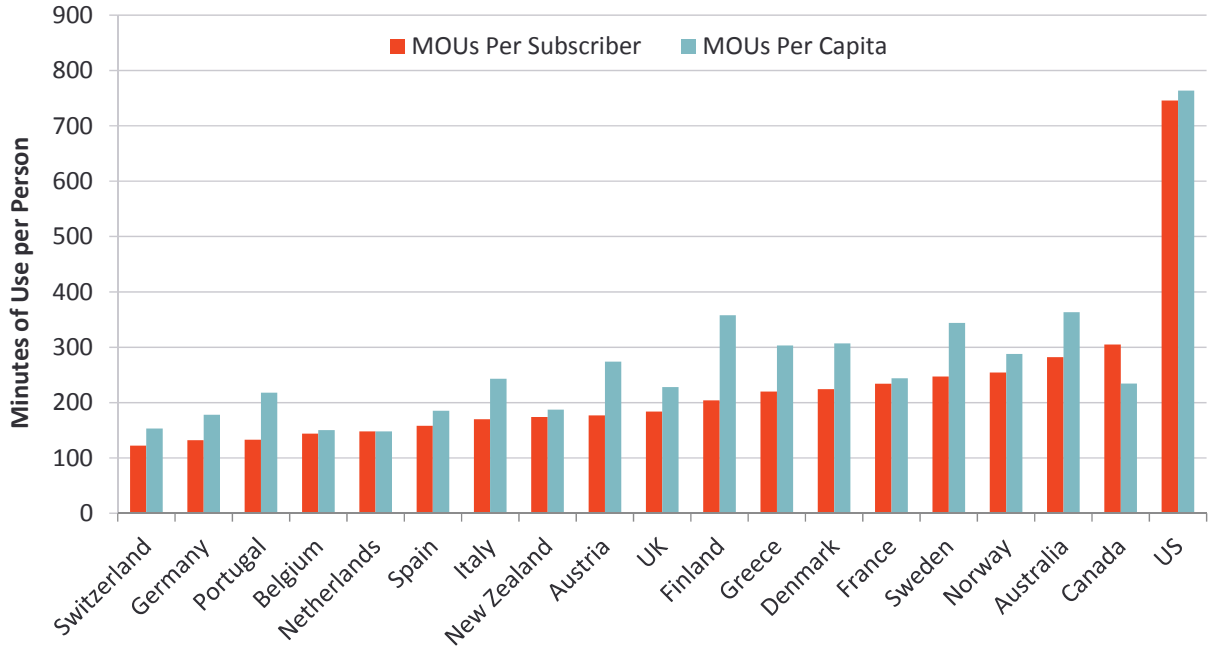
Figure 3. Average Revenue Per User by Country (2012)



Sources: Global Wireless Matrix 1Q2013. Table 1. Purchasing Power Parity Index from OECD.

Some studies, including C&W 2013, suggest that the relatively high ARPU of Canadian subscribers is explained in part by high usage per subscriber.[25] As shown in Figure 4 below, however, even on an adjusted basis,[26] the minutes of use (MOU) per subscriber is in fact higher in Canada than in other select developed countries, with the exception of the United States, where the MOU per subscriber is approximately 60% higher than in Canada. As shown in Figure 5, data usage per subscriber is similar to the United States but higher than Europe.

Figure 4. Adjusted Minutes of Use by Country (2012)



Source: Global Wireless Matrix 1Q2013. Table 1.
Note: US and Canada numbers reflect 20% adjustment for Calling Party Pays parity, suggested in Global Wireless Matrix, p. 263.

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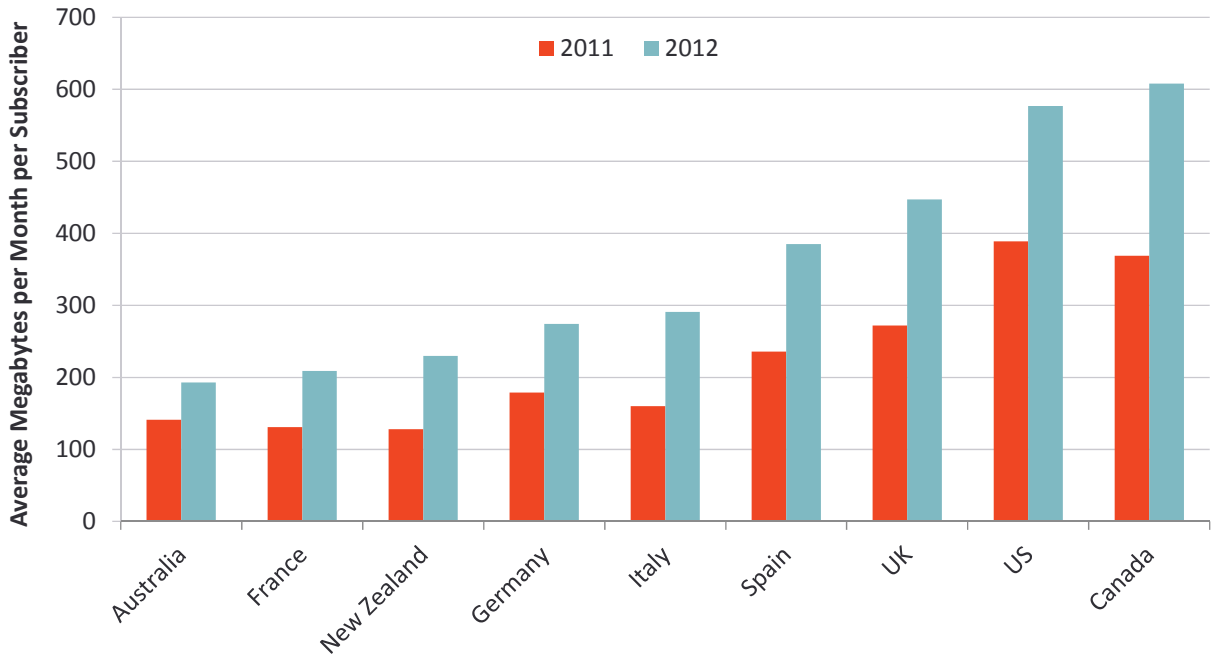
[25] See Church and Wilkins, "Wireless Competition in Canada: Response to the Competition Bureau," February 10, 2014, (hereinafter "Church and Wilkins 2014"), paragraph 7, which states: "[w]e find that Canada' high ARPU is explained by our high usage of wireless telecommunication services, particularly of data."

[26] This adjustment corrects for the difference in how minutes of use are recorded in countries using the CPPP (defined below), as opposed to Canada and the United States, which use a receiving party pays protocol. The Global Wireless Matrix suggests that reducing minutes of use in Canada and the United States by 20% is a conservative adjustment. See Bank of America/Merrill Lynch, "Global Wireless Matrix 1Q13," April 15, 2013, (hereinafter "Global Wireless Matrix"), p. 263.

Figure 5. Monthly Data Usage per Subscriber



Source: CISCO VNI Mobile Forecast Highlights, 2012-2017.

C&W 2013 also argues that, despite having a low overall consumer penetration, Canada's postpaid and smartphone penetration rates are generally in line with its European counterparts. As described in Figure 6 below, postpaid penetration rates range from approximately 40% to 110% in developed countries, and Canada's postpaid penetration rate is just over 60% (approximately similar to the UK and Germany).[27] Compared with the overall penetration rates illustrated in Figure 2, this suggests that a greater proportion of Canada's subscriptions are concentrated in postpaid and smartphone subscriptions when compared to its "peer" countries.

C&W 2013 also notes that European penetration rates may be inflated due in part to the calling party pays protocol (CPPP) and the popularity of prepaid subscriptions.[28] Nevertheless, Canada's overall penetration rate is less than in the United States, which does not use the CPPP.

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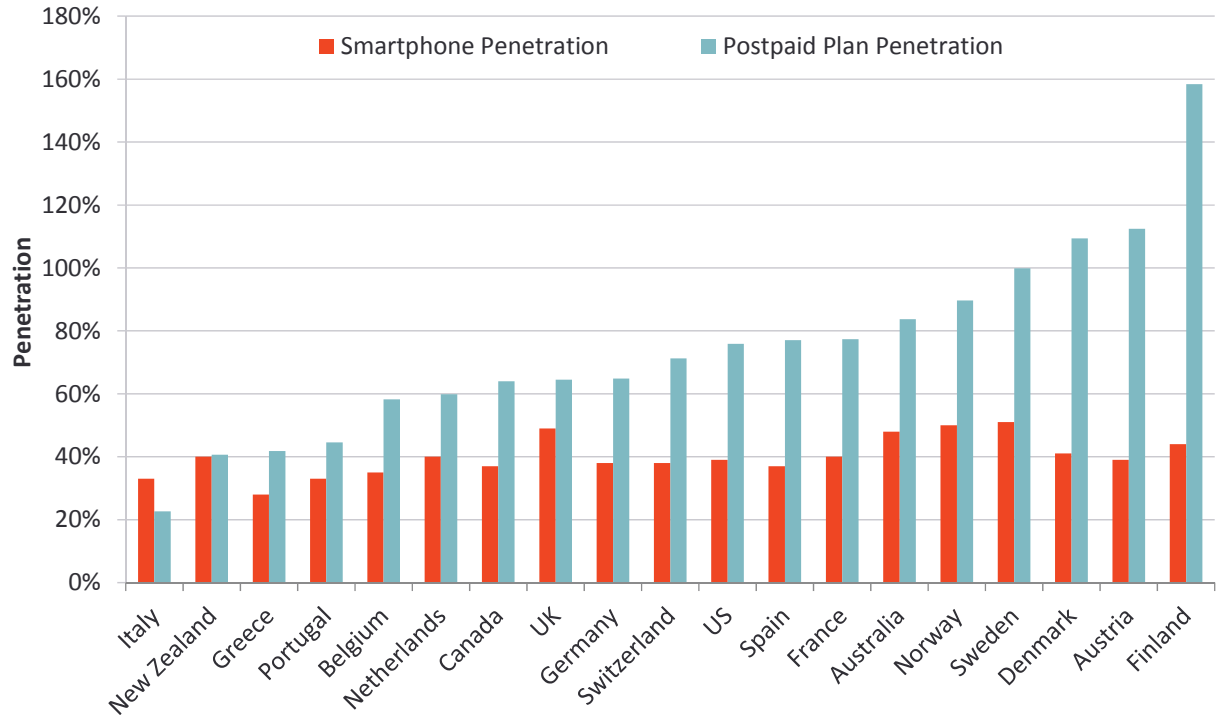
[27] Italy's is outside this set with a 20% postpaid penetration rate, while Finland's postpaid penetration rate is almost 160%. Both are outliers relative to other developed countries.

[28] On its face, CPPP makes it more affordable to subscribe to a wireless service if the subscriber is intending mainly to receive, rather than initiate, phone calls. This protocol also arguably creates incentives for a given customer to subscribe to multiple networks in order to avoid making off-network calls, which potentially leads to "double counting" when creating measures of market penetration. See C&W 2013, p. 7 for a discussion of this issue.

Figure 6. Penetration of Postpaid and Smartphone Service Plans (2012)



Source: Global Wireless Matrix 1Q2013. Table 1.

Alternatively, relatively low overall penetration, few prepaid services, and high usage suggest that the Canadian wireless market may lack sufficient product differentiation in comparison to other developed countries. The combination of lower penetration overall (particularly for prepaid services), higher ARPU, and higher smartphone usage suggests that wireless services in Canada are focused on higher end customers.

Postpaid and smartphone service plans are generally more expensive than prepaid and mobile phone service plans, respectively. In this case, the entry of an additional nationwide carrier may spur existing carriers to compete for a relatively unserved segment of the market by offering both lower prices and more actively promoting other types of service. As discussed below in Section IV.B, an additional nationwide carrier may act as a "maverick" and use a different pricing and service strategy from its competitors.

Navigant 2013 attempts to align Canada with the United States, and suggests that wireless market performance in Canada is "on par" with performance in the United States.[29] Yet, while there are important similarities between these two markets, there are at least three performance

[29] Whether the U.S. wireless market should be considered a competitive benchmark for Canada is beyond the scope of this paper.

differences that suggest the Canadian wireless market is less competitive than the U.S. wireless market.

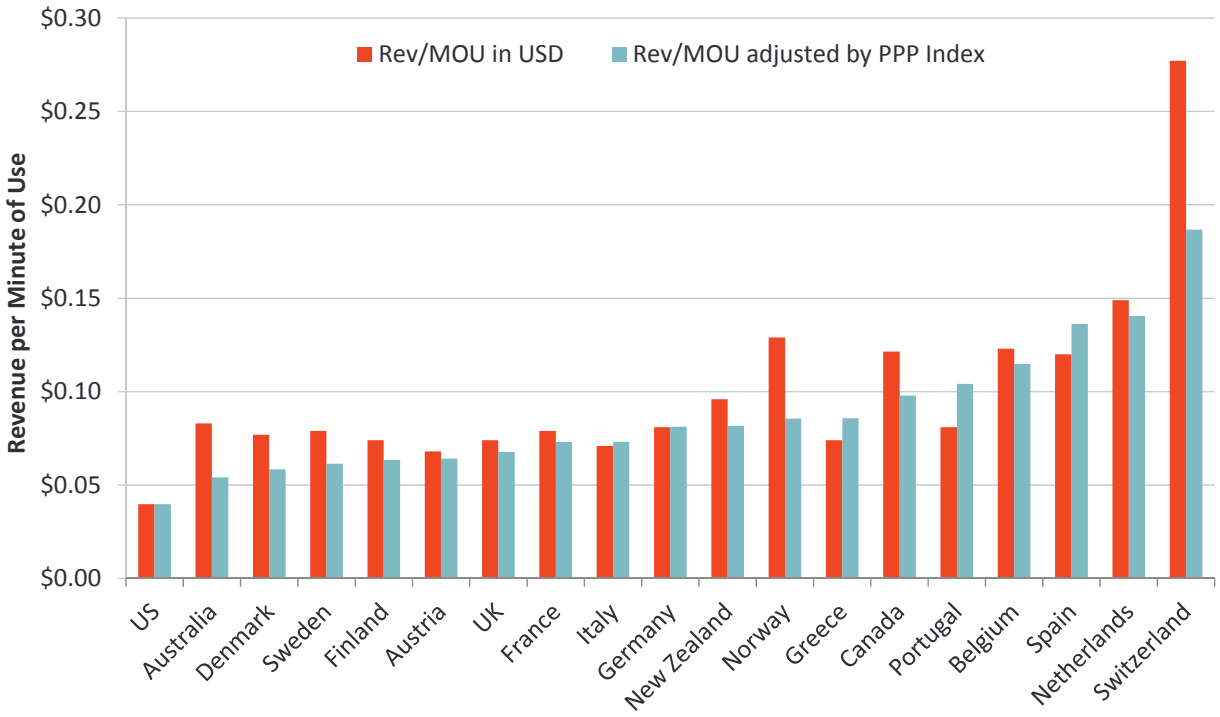
1. Proportionally fewer Canadians subscribe to wireless service. Penetration is at least 24% lower in Canada than the United States.

2. Canadian subscribers talk less. The minutes of use (MOU) per subscriber is approximately 60% lower in Canada than the United States.

3. Per-unit pricing is almost three times higher in Canada than the United States. As shown in Figure 7 below, Canada's voice revenue per MOU (US$0.12) is nearly three times that of the United States (US$0.04) and on par with many European countries. On a PPP basis, voice revenue per MOU in Canada is still over twice as high as the United States.[30]

Lower usage and higher per-minute pricing suggest that there is room for increased competition to expand the subscriber base, decrease prices, and still keep wireless carriers profitable in Canada.

Figure 7. Revenue per Minute of Use by Country (2012)



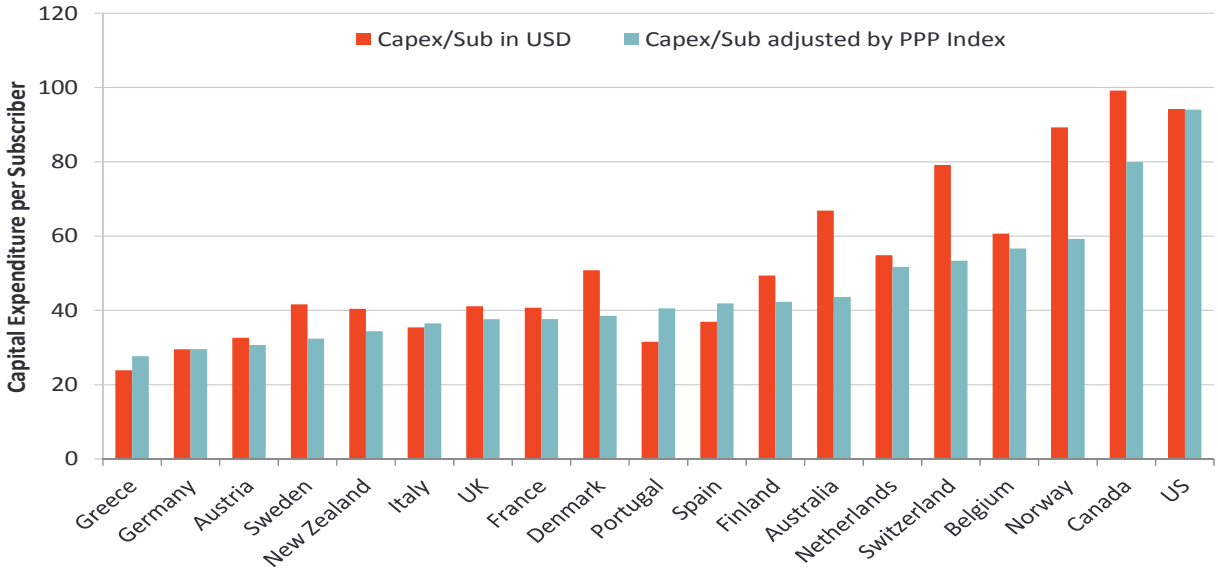
Sources: Global Wireless Matrix 1Q2013, Table 1. Purchasing Power Parity Index from OECD.
Note: Values for US and Canada are calculated as percent of average non-data service revenue per user per minute of use, with MOUs adjusted by 20% to reflect Calling Party Pays parity.

[30] Revenue per minute of use only reflects voice minutes and does not include data usage.

Other performance metrics also suggest that there are important differences between the Canadian and U.S. wireless industries. Navigant 2013 argues that capital expenditure (Capex) per connection has been relatively high in both Canada and the United States.[31]

Indeed, based on Figure 8 below, the Capex per subscriber in Canada is at least 5% higher than in the United States and at least 11% higher than each of the European comparison countries on an exchange rate basis. On a PPP basis, Canada is 15% lower than the United States and at least 35% higher than the European comparison countries. Although Canada's "capital intensity", as measured by the ratio of Capex to revenue in Figure 9, exceeds that of many developed countries, it lags behind the United States and several European countries.[32]

Figure 8. Capex Per Subscriber (2012)

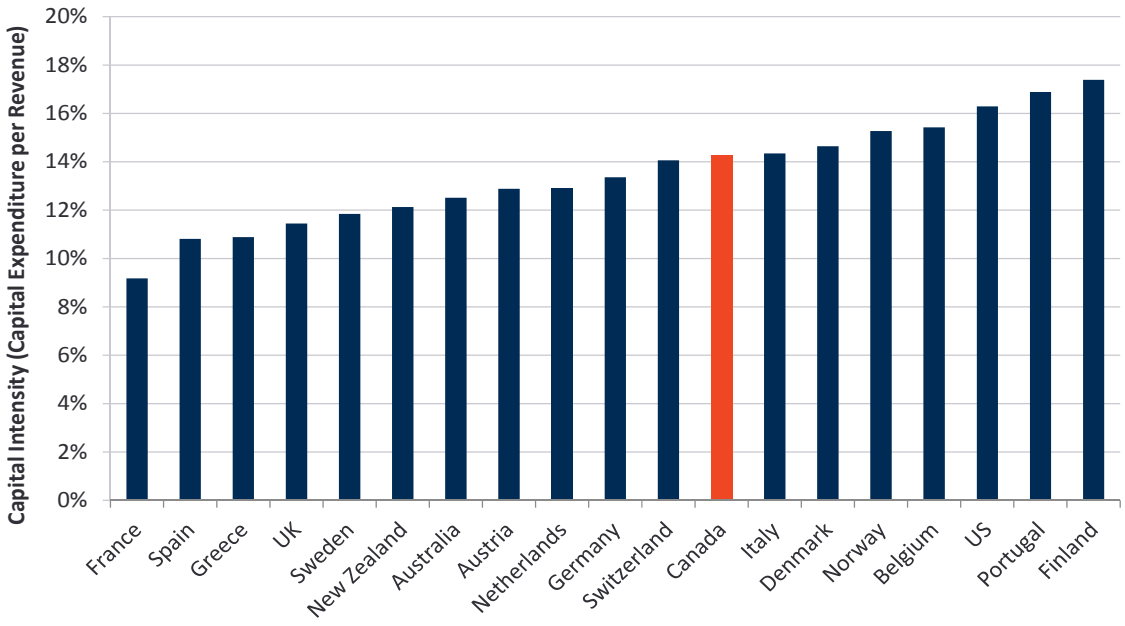


Sources: Global Wireless Matrix 1Q2013, Country Summary Tables 90-187. Purchasing Power Parity Index from OECD.
Note: Values reflect the weighted average of the three largest carriers in a country (by number of subscribers). Fewer carriers are used when data is unavailable.

31 Navigant 2013, p. 14.

32 Capex per subscriber and capital intensity are both based on the weighted average of the top three carriers in each country. Consequently, these numbers are not directly comparable to industry ARPU.

Figure 9. Capital Intensity (Capital/Revenue) (2012)



Source: Global Wireless Matrix 1Q2013. Country Summary Tables 90-187.
Note: Values reflect the weighted average of the three largest carriers in a country (by number of subscribers). Fewer carriers are used when data is unavailable.

To some extent, the large Capex per subscriber in Canada may be a function of the timing of Canada's LTE buildout. Since Canadian carriers have been in the midst of a large network buildout in 2012, we would expect recent capital expenditures to be relatively high. Consequently, we may observe a further reduction in Canada's capital intensity in the future.

Lastly, Navigant 2013 argues that another performance metric, EBITDA (*i.e.*, earnings before interest, taxes, depreciation, and amortization) margins for Canadian wireless carriers are similar in magnitude to those of the U.S. wireless carriers Verizon and AT&T.[33] The other two U.S. nationwide wireless carriers, Sprint and T-Mobile, however, have generally lower EBIDTA margins than Verizon and AT&T.[34] Figure 10 adds Sprint and T-Mobile to the carrier margin comparison. With the exception of Verizon, the EBITDA margins for Canada's three nationwide carriers are generally higher than those of U.S. nationwide wireless carriers. On average, the EBITDA margin for the Canadian carriers is almost 45%, while the average EBITDA margin for the U.S. carriers is just over 35%.

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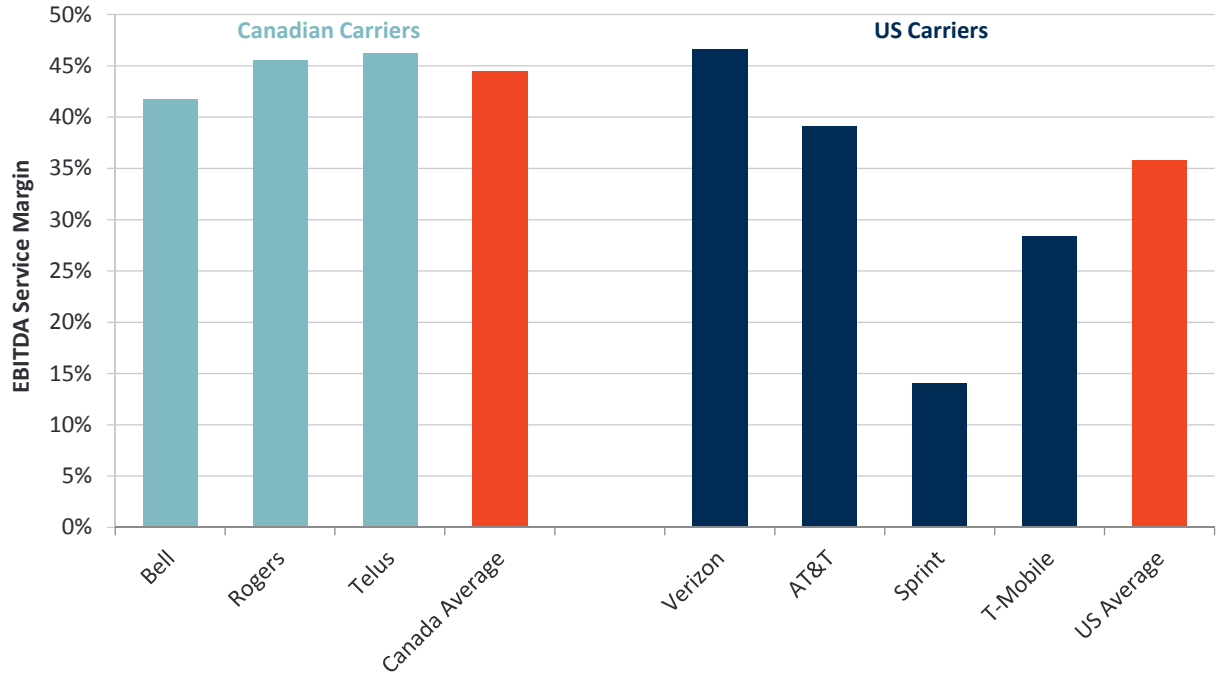
[33] The "EBITDA margin" is defined as EBITDA divided by revenues. See Navigant 2013, p. 11, Figure 6.

[34] For the purposes of this discussion, we use accounting margins in this section to be consistent with Navigant 2013. A more complete profitability analysis of participants in the Canadian wireless market is provided in Section III below.

Figure 10. Wireless EBITDA Margins of U.S. and Canadian Nationwide Carriers (2012)



Source: Global Wireless Matrix 1Q2013. Tables 101 and 187.

If the U.S. wireless services market is a valid competitive benchmark for wireless services in Canada, then most of the evidence presented here, including penetration rates, revenue per MOU, and EBITDA margins suggests that the Canadian market is less competitive than it potentially could be.

However, comparisons of Canada's market performance with the market performances of other developed countries cannot provide conclusive evidence regarding Canadian wireless competitiveness.[35] As mentioned above, cross-country comparisons do not control for demand and cost factors, such as differences in consumer preferences and network costs that are likely to affect wireless industry development. Importantly, Canada has unique characteristics compared to its peer group, including a relatively modest population and vast geographic territory.

In order to assess market power in the Canadian wireless market, we must focus on the current market performance of Canadian wireless carriers, and the cost and demand conditions facing these carriers and other prospective entrants. In so doing, we can more fully understand the economic benefits and costs arising from additional entry into the Canadian wireless market.

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[35] Church and Wilkins 2014 (paragraph 8) notes that "international comparisons of price and output are not reflective of competition or market power. In assessing competition, what matters is how closely prices track costs in a country. That, in turn, involves a comparison of prices and costs in a country, not a comparison of prices between countries."

III. An Assessment of the Profitability of Canadian Wireless Carriers

To assess whether significant market power is present in a market, economists tend to look at market conduct and performance as opposed to solely relying on evidence provided by market structure. For that reason, we have undertaken an analysis of the profitability of specific wireless carriers in Canada, focusing on TELUS' and Rogers' wireless divisions. We find that both companies are generally earning an above-normal rate of return on their wireless investments, or what economists refer to as "positive" or "excess" economic profits.

One way to assess the extent of a firm's economic profits is to compare the internal rate of return (IRR) to its cost of capital. Absent idiosyncratic cost differences relative to other firms in the market, a firm that faces effective competition will earn, on average, an IRR that is comparable to its required cost of capital.[36] A firm's cost of capital is the rate of return that investors require to supply capital to the firm, which is the (risk-adjusted) return required by the market on the debt and equity used to finance the firm's investments.[37] This is sometimes referred to as the "opportunity cost" of the firm's capital. When a firm is earning an actual rate of return that exceeds its cost of capital, the firm is considered to be earning positive economic profits, or equivalently, an above-normal rate of return.

Consequently, an economically valid test for evaluating whether a firm has earned excess profits is to compare its "long run" IRR with its cost of capital. This approach, if properly implemented, is conceptually sound and supported by the economics literature.[38] The benefit of a long run IRR is that it ensures that the analysis captures all of the returns associated with each investment, which may take decades to occur.

In the case of TELUS' and Rogers' wireless businesses, a long run IRR should begin with the first years of operations and extend far enough into the future to include returns for the most recent

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[36] See, for example, Dennis W. Carlton and Jeffrey M. Perloff, Modern Industrial Organization, Fourth Edition (2005), chapter 8. If many or all firms in the market are achieving an IRR in excess of their individual costs of capital, this alone would be indicative of supracompetitive profits and likely market power, as cost-advantage by definition cannot apply to most or all firms in a market.

[37] In standard finance theory, an investor's required return is based, in part, on the returns they expect to earn on an alternative investment of equivalent risk. See, Richard A. Brealey, Stewart C. Myers, and Franklin Allen, Principles of Corporate Finance, Tenth Edition (2011), (hereinafter "Brealey, Myers and Allen"), chapter 5, p. 103.

[38] Franklin M. Fisher and John J. McGowan, "On the Misuse of Accounting Rates of Return to Infer Monopoly Profits," American Economic Review, 73(1), 1983; Dennis W. Carlton and Jeffrey M. Perloff, Modern Industrial Organization, Fourth Edition (2005), Chapter 8. Jeffrey Church and Roger Ware, Industrial Organization: A Strategic Approach (2000), Chapter 12.

investments. Consequently, we estimate IRRs through 2018, 2024, and 2030.[39] The results of our analysis of TELUS' and Rogers' wireless division profitability is consistent with both TELUS and Rogers earning above-normal returns for their wireless divisions. Each company's wireless IRR generally exceeds its associated cost of capital.

When a business's IRR exceeds its associated cost of capital, this outcome may result from the company's ability to exercise market power. As stated by C&W 2013, "returns that are substantially above the opportunity cost of capital over the lifecycle of an investment project" are "[a] necessary, but not sufficient, condition for monopoly profits levels and market power."[40] Alternatively, a finding of above-normal profits for any single firm in a market could result from firm-specific cost advantages relative to other competitors.

While evidence suggests that incumbent carriers are generally earning above-normal profits, the analysis in this section does not indicate how these profits would change in the presence of an additional nationwide carrier. Furthermore, a new carrier would not enter the market unless it expected to earn at least a normal (risk-adjusted) return on the investment required to create an additional nationwide network. The analysis in Section IV offers some insight regarding these issues.

A. IRR Calculation for TELUS Wireless

Our calculation of the lifecycle IRRs for TELUS' wireless business ranges from 11.6% to 16.8% through 2018, and 13.8% to 17.9% through 2030. This range of IRRs is based on alternative treatments of the amount that TELUS "invested" when it acquired Clearnet Communications. We calculate an "upper bound" IRR for TELUS by aggregating Clearnet's own financial performance prior to its acquisition by TELUS, with TELUS' financial performance prior to and after this acquisition. The "lower bound" IRR is calculated by treating all of the money spent on the acquisition of Clearnet as investment.[41] As explained in Appendix A, we believe the actual IRR is likely closer to the upper bound than the lower bound.[42]

As shown in Table 2, we calculate IRRs as nominal, pre-tax returns[43] by identifying the historical and projected cash flows of TELUS' wireless business from TELUS' financial statements. Next,

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[39] We also calculate and report IRRs through 2012, but only for comparison to return estimates developed by others. See, for example, C&W 2013, p. 25.

[40] C&W 2013, p. 24.

[41] See Appendix A for further discussion.

[42] For the purposes of exposition, we show the upper bound IRR calculation in Table 2. We present the lower bound IRR calculation in Appendix A.

[43] Although we also would like to calculate a TELUS Wireless IRR in nominal, after-tax terms, this was not feasible based on the financial data available. The historical development of, and financial

Continued on next page

we calculate the "discount rate" that would equate those cash flows to the Capex and other investments made by TELUS.

We calculate wireless cash flows from TELUS financial reports, which began in 1990; BC Tel, which merged with TELUS in 1998; and Clearnet, which was acquired by TELUS in late 2000. Our upper bound free cash flow (FCF) is displayed in Column 11 of Table 2. This represents the total earnings before interest, taxes, depreciation and amortization (EBITDA) of these businesses, less capital expenditure and other cash investments.

To project future wireless cash flows out to 2018, 2024, and 2030, we assume that TELUS will replicate its 2012 financial performance through 2030, on an inflation-adjusted basis.[44] This effectively assumes that the cash flows and capital expenditures continue at a "steady state" after 2012. If, instead, the size of TELUS' wireless business grows in the future, then its 2012 financial performance would understate its likely future financial performance under the current state of market competition. This, in turn, would understate its IRR.

Based on this methodology, the calculated upper-bound IRR is 17.9%. This represents the nominal pre-tax rate of return on TELUS' observed and projected cash flows through 2030 based on all capital expenditure and other cash investments made by the combined TELUS entity.[45]

Continued from previous page

reporting for, TELUS' operations complicate any estimation of the corporate income taxes needed for an after-tax return calculation.

In particular, TELUS as it stands today is the product of: the 1990 privatization of Alberta Government Telephone Commission (AGT), a crown corporation, to create TELUS Corporation; the acquisition in 1995 of Edmonton Telephone Corporation (ED TEL) from the City of Edmonton; the 1998 merger of TELUS with BC Tel, the telecommunications firm that served British Columbia, to form BCT.TELUS, (subsequently renamed "TELUS"); the 2000-2001 acquisition of QuebecTel Group, a provider of wireline and wireless telecommunications, information technology, and other services in Quebec; and the $6.6 billion acquisition in late 2000 of Clearnet Communications.

44 C&W 2013 makes an alternative calculation of Rogers' IRRs, assuming that Rogers' annual cash flows are $1 billion between 2014 and 2030. This is consistent with Rogers' annual real cash flows over the 2010-2012 period if they persist annually through 2030. See C&W 2013, p. 26, n. 64.

45 More formally, this figure is the level of the annual discount rate that equates the present value of the positive cash flows, once the business is up and running, to the present value of the cash losses incurred to get the business going, where the discount rate represents the (annual) rate at which future earnings (or losses) are discounted back to the present.

This is consistent with the notion of a "time value of money," where investors need to be compensated for forsaking the use of money today in return for a payoff at a future date. As mentioned previously, when a firm's return from its investments (*i.e.*, IRR) exceeds the return required by the market for receiving a future payoff (*i.e.*, the firm's cost of capital), that firm is considered to be earning above-normal profits.

Table 2. TELUS Wireless Nominal, Pre-Tax IRR ($ M)

Year	BC TEL Nominal Cash Flows			TELUS Nominal Cash Flows Excluding Clearnet			Clearnet	BC TEL, TELUS, and Clearnet Combined Nominal Cash Flows			
	EBITDA	Capex	Other Cash Investments	EBITDA	Capex	Other Cash Investments	Total Cash Outflows	EBITDA	Capex	Other Cash Investments	Pre-Tax Free Cash Flow (nominal $)
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
1988	1.8	11.1	0.0				0.0	1.8	11.1	0.0	-9.2
1989	8.9	18.3	0.0				0.0	8.9	18.3	0.0	-9.5
1990	21.7	37.2	0.0	0.0	16.1	79.2	0.0	21.7	53.2	79.2	-110.7
1991	29.8	29.0	0.0	5.3	20.5	0.0	0.0	35.1	49.5	0.0	-14.3
1992	42.2	29.0	0.0	11.5	19.3	0.0	0.0	53.7	48.3	0.0	5.4
1993	59.5	44.0	0.0	25.0	15.0	0.0	24.0	84.5	59.0	24.0	1.5
1994	86.1	48.0	0.0	43.0	27.4	0.0	168.5	129.1	75.4	168.5	-114.8
1995	117.8	77.0	0.0	65.9	50.8	116.9	137.4	183.7	127.8	254.3	-198.3
1996	144.2	86.0	0.0	127.2	73.3	0.0	165.5	271.4	159.3	165.5	-53.4
1997	177.9	102.2	0.0	188.0	122.7	0.0	765.0	365.9	224.9	765.0	-624.0
1998				375.3	192.6	0.0	568.7	375.3	192.6	568.7	-386.0
1999				379.4	165.2	0.0	571.3	379.4	165.2	571.3	-357.1
2000				307.4	222.9	146.1	395.0	307.4	222.9	541.1	-456.6
2001				294.0	643.0	427.2		294.0	643.0	427.2	-776.2
2002				530.0	455.1	4.6		530.0	455.1	4.6	70.3
2003				817.0	359.9	0.0		817.0	359.9	0.0	457.1
2004				1,144.0	354.7	0.0		1,144.0	354.7	0.0	789.3
2005				1,445.0	404.8	0.0		1,445.0	404.8	0.0	1,040.2
2006				1,752.9	427.4	0.0		1,752.9	427.4	0.0	1,325.5
2007				1,906.0	551.0	0.0		1,906.0	551.0	0.0	1,355.0
2008				2,005.0	548.0	882.0		2,005.0	548.0	882.0	575.0
2009				1,933.0	770.0	0.0		1,933.0	770.0	0.0	1,163.0
2010				2,020.0	463.0	0.0		2,020.0	463.0	0.0	1,557.0
2011				2,186.0	508.0	81.0		2,186.0	508.0	81.0	1,597.0
2012				2,467.0	711.0	84.0		2,467.0	711.0	84.0	1,672.0
2013											1,705.4
2014											1,739.5
2015											1,774.3
2016											1,809.8
2017											1,846.0
2018											1,882.9
2019											1,920.6
2020											1,959.0
2021											1,998.2
2022											2,038.2
2023											2,078.9
2024											2,120.5
2025											2,162.9
2026											2,206.2
2027											2,250.3
2028											2,295.3
2029											2,341.2
2030											2,388.0
IRR											
1988 - 2012:											14.0%
1988 - 2018:											16.8%
1988 - 2024:											17.6%
1988 - 2030:											17.9%

Notes and Sources:
[1] - [3]: BC Telecom Annual Financial Data.
[4] - [6]: TELUS Annual Financial Data.
[7]: Clearnet Communications Annual Financial Data.
[8]: [1] + [4].
[9]: [2] + [5].
[10]: [3] + [6] + [7].
[11]: [8] - [9] - [10].
2013-2030 values grow with 2% assumed inflation.

Table 3 shows the range of TELUS' estimated wireless IRRs. Using our upper bound estimates, if we assume that TELUS generates no further wireless cash flows from its pre-existing investments after 2018, 2024, or 2030, then the estimated pre-tax nominal IRRs equal 16.8%, 17.6%, or 17.9% respectively.[46] Alternatively, the lower bound methodology produces estimated pre-tax nominal

[46] In this case, we grow TELUS' 2012 cash flows at the annual rate of inflation in each year from 2013 to the assumed end date. This is consistent with holding TELUS' cash flows constant in "real" terms after 2012.

IRRs equal to 11.6%, 13.2%, and 13.8% over those same time periods. For comparison, Table 3 also shows the IRR calculation through 2012.

To assess whether TELUS' wireless division is earning above-normal profits for its wireless business, we compare these returns on investment (*i.e.*, IRRs) with the cost of capital typically required by investors to finance businesses of comparable risks. For this purpose, Table 3 also provides estimates of TELUS' pre-tax weighted-average cost of capital (WACC). As explained in Appendix A, these are derived, in part, using Bloomberg data.[47]

Table 3. TELUS Wireless Pre-Tax Nominal IRR and WACC

Period	Lower Bound IRR (Pre-Tax)	Upper Bound IRR (Pre-Tax)	WACC (Pre-Tax)
1988 - 2012	6.8%	14.0%	12.8%
1988 - 2018	11.6%	16.8%	12.2%
1988 - 2024	13.2%	17.6%	11.8%
1988 - 2030	13.8%	17.9%	11.5%

Source: Brattle Group analysis. See Appendix A.

In nearly all cases, the IRR exceeds the WACC for the time horizons that we analyze, implying that TELUS is earning above-normal returns on its investment. The excess of the upper bound IRR estimate over the associated WACC equals 4.6%, 5.8%, and 6.4% for the period from 1988 through 2018, 2024, and 2030, respectively. The excess IRR is -0.6%, 1.4% and 2.3%, respectively, for our lower bound estimates. As shown in Table 3, our qualitative conclusion—

[47] To derive pre-tax costs of capital, we "gross up" TELUS' after-tax WACC for each year by dividing by (1 – tax rate), using tax rates that approximate TELUS' statutory corporate income tax rate as of that year. In general, this adjustment will tend to overstate the pre-tax cost of capital for TELUS, which will cause us to understate the magnitude of any above-normal returns earned by TELUS.

In standard finance theory, the value of an investment equals its after-tax cash flows discounted at the after-tax cost of capital. Ideally, the pre-tax cost of capital would be the discount rate that equates pre-tax cash flows to this same investment value. However, our calculated pre-tax cost of capital is larger than this "ideal" rate, because it does not consider tax savings realized through the firm's use of depreciation on its capital investments (which reduces a firm's tax liability).

The weights for the WACC are determined by adjusting TELUS' annual Capex (and other investments) for inflation to obtain a measure of "real" Capex in each year. The weight applied to the pre-tax cost of capital in a given year is then the real capital expenditure (and other investments) in that year divided by the total real capital expenditure (and other investments) over the relevant time period.

See Appendix A for further details on TELUS' WACC calculation.

that TELUS seems to be earning excess returns—is not generally sensitive to the end date of the analysis.[48]

B. IRR Calculation for Rogers Wireless

Our IRR calculation for Rogers Wireless also begins with estimates of its FCFs, which we derive from Rogers' financial statements.[49] From this information, we calculate nominal after-tax cash flows and compare these with Rogers' cost of capital.[50] As described below, we estimate that Rogers' nominal after-tax IRRs equal 11.2%, 12.3%, and 12.7% for the periods from 1988 through 2018, 2024, and 2030, respectively.

We calculate three IRRs, assuming conservatively that Rogers' 2012 wireless financial performance is maintained through 2018, 2024, and 2030, respectively. Similar to our analysis of TELUS, we assume that Rogers' 2012 cash flows are essentially in "steady state" for the future, only increasing with the rate of inflation after 2012.

This assumption effectively means that we are treating the number of Rogers' wireless subscribers, their minutes of use, and the associated revenues and costs of the network as "static," on an inflation-adjusted basis. This is a conservative assumption since Rogers has made recent investments to further grow its wireless business. These investments not only diminish cash flows in recent years relative to what might be "sustainable" in the future, but they are likely to result in greater numbers of subscribers, revenues, and profits in the future.

For example, Rogers has had its five highest years of wireless Capex (on a nominal and inflation-adjusted basis) in the five most recent years (*i.e.*, 2007 to 2012).[51] One would expect that capital investments made between 2008 and 2012 would continue to pay off and expand cash flows well past 2012.[52] In particular, Rogers acquired 20 MHz of AWS spectrum in 2008, and made considerable investments in building out a new network using this spectrum between 2008 and

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48 Although the IRR is lower than the WACC for the lower bound 2018 IRR, this scenario is unlikely for two reasons. First, as explained in more detail in the Appendix, we believe the actual IRR is likely closer to the upper bound than the lower bound. Second, as explained in footnote 47, the pre-tax WACC is likely overstated.

49 See Appendix Table A-5 for detailed calculation of Rogers' FCF.

50 We use Roger's nominal, *after-tax* IRRs and WACCs because more data were available for Rogers than for TELUS, whereas we use TELUS' nominal, *pre-tax* IRRs and WACCs.

51 Church and Wilkins 2013, Table 4.

52 C&W 2013 argue that measuring profitability using a long-run IRR calculation is appropriate in light of the industry's significant "sunk and fixed costs" and "economies of scale." Lifecycle returns on wireless investments can extend many years after the investments initially were made. See, for example, C&W 2013, p. 24.

2012. Rogers will be earning returns from this spectrum and network investment for years to come.

In addition, Rogers made substantial investments in acquiring new wireless subscribers over this period, which will likely result in greater future revenues. The number of Rogers' wireless subscribers grew by 18.8% between 2008 and 2012.[53] Recent performance suggests that Rogers will continue to grow its subscriber base and its FCF. In fact, Rogers' cash flow increased by 12.2% over the first three quarters of 2013 when compared with same quarters in 2012.[54]

Rogers' wireless cash flows are presented below in Table 4, where we assume conservatively that Rogers' future cash flows are maintained at their 2012 level (after adjusting for an annual inflation rate of 2%). From these cash flows, we estimate that Rogers' nominal after-tax IRRs equal 11.2%, 12.3%, and 12.7% for the period from 1988 through 2018, 2024, and 2030, respectively.

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53 See Annual Reports for Rogers Communications, Inc., 2008-2012.

54 For additional detail, see Table A-6.

Table 4. Estimated Nominal, After-Tax Rogers Wireless IRR (Nominal CAD '000)

Year	EBITDA	Capex and Other Investments	Pre-Tax Free Cash Flow	Depreciation and Amortization Expense	EBIT	Application of Tax Loss Carry Forwards	Taxable Income	Statutory Income Tax Rate	Income Taxes	After-Tax Free Cash Flow
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1986	-$12,804	$62,814	-$75,618	$3,141	-$15,945	$0	$0	52.3%	$0	-$75,618
1987	-$1,771	$52,651	-$54,422	$5,773	-$7,544	$0	$0	52.3%	$0	-$54,422
1988	$17,797	$91,646	-$73,849	$6,856	$10,941	$10,941	$0	49.8%	$0	-$73,849
1989	$30,026	$261,328	-$231,302	$31,005	-$979	$0	$0	45.0%	$0	-$231,302
1990	$76,156	$495,568	-$419,412	$92,484	-$16,328	$0	$0	44.0%	$0	-$419,412
1991	$99,605	$162,456	-$62,851	$112,630	-$13,025	$0	$0	44.0%	$0	-$62,851
1992	$129,452	$240,731	-$111,279	$148,681	-$19,229	$0	$0	44.0%	$0	-$111,279
1993	$198,600	$181,400	$17,200	$169,552	$29,048	$29,048	$0	44.0%	$0	$17,200
1994	$289,900	$182,403	$107,497	$188,031	$101,869	$33,061	$68,808	44.0%	$30,276	$77,221
1995	$315,600	$185,600	$130,000	$208,440	$107,160	$0	$107,160	44.0%	$47,150	$82,850
1996	$351,100	$553,800	-$202,700	$214,823	$136,277	$0	$136,277	44.5%	$60,643	-$263,343
1997	$395,700	$604,700	-$209,000	$255,958	$139,742	$0	$139,742	44.5%	$62,185	-$271,185
1998	$395,100	$301,300	$93,800	$274,264	$120,836	$0	$120,836	44.5%	$53,772	$40,028
1999	$422,300	$420,250	$2,050	$285,458	$136,842	$0	$136,842	44.5%	$60,895	-$58,845
2000	$410,900	$526,000	-$115,100	$334,619	$76,281	$0	$76,281	44.0%	$33,564	-$148,664
2001	$411,900	$1,051,300	-$639,400	$382,608	$29,292	$0	$29,292	41.7%	$12,215	-$651,615
2002	$527,700	$564,600	-$36,900	$457,133	$70,567	$0	$70,567	38.6%	$27,239	-$64,139
2003	$727,600	$411,900	$315,700	$518,599	$209,001	$0	$209,001	36.6%	$76,494	$239,206
2004	$950,400	$1,946,900	-$996,500	$497,674	$452,726	$0	$452,726	35.3%	$159,812	-$1,156,312
2005	$1,337,000	$585,000	$752,000	$624,000	$713,000	$713,000	$0	36.1%	$0	$752,000
2006	$1,987,000	$684,000	$1,303,000	$630,000	$1,357,000	$1,037,000	$320,000	35.8%	$114,560	$1,188,440
2007	$2,589,000	$822,000	$1,767,000	$560,000	$2,029,000	$0	$2,029,000	35.2%	$714,208	$1,052,792
2008	$2,806,000	$1,937,000	$869,000	$588,000	$2,218,000	$0	$2,218,000	32.7%	$725,286	$143,714
2009	$3,042,000	$905,000	$2,137,000	$660,000	$2,382,000	$0	$2,382,000	32.3%	$769,386	$1,367,614
2010	$3,173,000	$1,010,000	$2,163,000	$648,000	$2,525,000	$0	$2,525,000	30.5%	$770,125	$1,392,875
2011	$3,036,000	$1,192,000	$1,844,000	$674,000	$2,362,000	$0	$2,362,000	28.0%	$661,360	$1,182,640
2012	$3,063,000	$1,123,000	$1,940,000	$703,388	$2,359,612	$0	$2,359,612	26.4%	$622,937	$1,317,063
2013	$3,124,260	$1,145,460	$1,978,800	$717,456	$2,406,804	$0	$2,406,804	26.4%	$635,396	$1,343,404
2014	$3,186,745	$1,168,369	$2,018,376	$731,805	$2,454,940	$0	$2,454,940	26.4%	$648,104	$1,370,272
2015	$3,250,480	$1,191,737	$2,058,744	$746,441	$2,504,039	$0	$2,504,039	26.4%	$661,066	$1,397,677
2016	$3,315,490	$1,215,571	$2,099,918	$761,370	$2,554,119	$0	$2,554,119	26.4%	$674,288	$1,425,631
2017	$3,381,800	$1,239,883	$2,141,917	$776,598	$2,605,202	$0	$2,605,202	26.4%	$687,773	$1,454,143
2018	$3,449,435	$1,264,680	$2,184,755	$792,130	$2,657,306	$0	$2,657,306	26.4%	$701,529	$1,483,226
2019	$3,518,424	$1,289,974	$2,228,450	$807,972	$2,710,452	$0	$2,710,452	26.4%	$715,559	$1,512,891
2020	$3,588,793	$1,315,773	$2,273,019	$824,132	$2,764,661	$0	$2,764,661	26.4%	$729,871	$1,543,149
2021	$3,660,569	$1,342,089	$2,318,480	$840,614	$2,819,954	$0	$2,819,954	26.4%	$744,468	$1,574,012
2022	$3,733,780	$1,368,931	$2,364,849	$857,427	$2,876,353	$0	$2,876,353	26.4%	$759,357	$1,605,492
2023	$3,808,456	$1,396,309	$2,412,146	$874,575	$2,933,880	$0	$2,933,880	26.4%	$774,544	$1,637,602
2024	$3,884,625	$1,424,236	$2,460,389	$892,067	$2,992,558	$0	$2,992,558	26.4%	$790,035	$1,670,354
2025	$3,962,317	$1,452,720	$2,509,597	$909,908	$3,052,409	$0	$3,052,409	26.4%	$805,836	$1,703,761
2026	$4,041,563	$1,481,775	$2,559,789	$928,106	$3,113,457	$0	$3,113,457	26.4%	$821,953	$1,737,836
2027	$4,122,395	$1,511,410	$2,610,985	$946,668	$3,175,727	$0	$3,175,727	26.4%	$838,392	$1,772,593
2028	$4,204,843	$1,541,638	$2,663,204	$965,602	$3,239,241	$0	$3,239,241	26.4%	$855,160	$1,808,045
2029	$4,288,939	$1,572,471	$2,716,468	$984,914	$3,304,026	$0	$3,304,026	26.4%	$872,263	$1,844,206
2030	$4,374,718	$1,603,921	$2,770,798	$1,004,612	$3,370,106	$0	$3,370,106	26.4%	$889,708	$1,881,090
Nominal IRR										
1986-2012:			12.2%							8.1%
1986-2018:			14.5%							11.2%
1986-2024:			15.3%							12.3%
1986-2030:			15.6%							12.7%

Notes and Sources:

[1] - [2], [4]: Source for 1986-2012: Rogers Communications annual financial data. An annual inflation rate of 2% is applied 2013 onwards.
1986 and 1987 depreciation and amortization expense is approximated assuming capital expenditures were depreciated over 10 years, straight line, with mid-year convention.

[3]: [1] - [2].

[5]: [1] - [4].

[6]: Negative EBIT amounts in [5] carried forward up to 7 years to offset positive EBIT in [5]. Source for NOL expiration years: Canada Revenue Agency. Tax loss carryforwards for 2005 & 2006 were acquired from Microcell (source: 2004 Annual Report for Rogers Communications, Inc., page 97.)

[7]: Maximum of 0 and ([5] - [6]).

[8]: Annual Reports for Rogers Communications, Inc.

[9]: [7] x [8].

[10]: [3] - [9].

In Table 5 we compare these IRRs, along with the calculated IRR through 2012, to Rogers' estimated WACC. These WACC estimates equal 9.0%, 8.5%, 8.2%, and 8.1% for the period from 1988 through 2012, 2018, 2024, and 2030, respectively.

If Rogers' cash flows from its prior wireless investments stopped at 2012, it would appear that Rogers' internal return on its investments is below its WACC. However, this understates the underlying profitability of Rogers' wireless business. Assuming conservatively that these past investments continue to pay off for an additional 6, 12, or 18 years beyond 2012, we estimate that Rogers' IRR on its investments exceeds the associated WACC by approximately 2.7%, 4.1%, and 4.6%, respectively. Similar to our analysis of TELUS, our qualitative conclusions do not hinge on which post-2018 end date to use.

Table 5. Rogers After-Tax Nominal IRR and WACC

Period	IRR	WACC
1986 - 2012	8.1%	9.0%
1986 - 2018	11.2%	8.5%
1986 - 2024	12.3%	8.2%
1986 - 2030	12.7%	8.1%

Source: Brattle Group analysis. See Appendix A.

To the extent that Rogers' 2012 performance understates its future wireless cash flows, Rogers' IRRs are higher than those presented above. If expenditures were made in 2012 to grow, rather than maintain, its business, one might expect that Rogers' future cash flows arising from its pre-existing investments would outperform the projections used in our analysis.[55] Moreover, it is conservative to assume that cash inflows from these past investments will have ended by the benchmark dates used in our analysis.

C. IRR Conclusions

Our analysis of both TELUS' and Rogers' wireless business IRRs suggests that both are earning above-normal returns on their investment relative to their costs of capital. Above-normal returns can arise for a number of reasons, including the exercise of market power and firm-specific cost or other advantages. Although it is quite possible for a single firm in a concentrated industry to be earning above-normal profits as a result of firm-specific advantages, it is less likely

[55] Table 4 shows that Rogers Wireless annual capital investments exceeded depreciation and amortization by about 60% for the period 2010 through 2012. To the extent that accounting measures of depreciation and amortization represent true "economic" depreciation and amortization of the assets involved, this excess suggests that Rogers Wireless' capital spending was above the amount needed to maintain the real value of its property plant and equipment (PP&E). When a firm's capital spending exceeds this maintenance level, this excess should be expected to generate real growth in future cash flows.

that two of the three major players in the wireless industry are earning above-normal profits solely due to firm-specific advantages.

IV. Potential Entry Effects of an Additional Carrier

Even though certain evidence regarding firm profitability and market performance is consistent with the presence of market power in the Canadian wireless market (as well as with other possible explanations), this evidence by itself is not sufficient to imply that Canada would be better off with the emergence of an additional nationwide wireless carrier.

Certain key questions need to be analyzed in order to assess whether spectrum allocation and other policies geared toward sustaining an additional nationwide carrier would be beneficial from a competition and public policy standpoint.[56] These questions include:

- What are the likely effects on wireless consumers, wireless providers, and market efficiency associated with the emergence of an additional nationwide carrier?
- What would be the effects on incumbent wireless providers from setting aside spectrum for an additional nationwide carrier? More specifically, what is the increase in network buildout costs sustained by incumbent wireless providers if less spectrum is made available to them?

In this section, we offer analysis to provide some insight into these questions. In particular, we analyze the reactions of financial markets to "news" indicating an increased or reduced likelihood of the emergence of an additional nationwide wireless carrier. We focus on the reactions in the Canadian equity markets to Verizon's announced interest in potentially entering, or not entering, the Canadian wireless market.

We use these news announcements to assess the impact on Rogers', TELUS', and Bell's future profits that would be associated with the emergence of a strong additional carrier, such as

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[56] Church and Wilkins 2014 suggests that the "natural limit" for the number of wireless carriers "in most countries appears to be three." (See Church and Wilkins 2014, paragraph 18.) It bases this conclusion on cross-country comparisons of HHIs and firm shares. (See C&W 2013, pp. 28-29.) As discussed above, it is difficult to make conclusions based on international comparisons. Instead, we attempt to address how an additional carrier would affect the Canadian wireless industry specifically.

Church and Wilkins 2014 describe a similar potential analytical approach to that undertaken here: "what matters is how closely prices track costs in a country. That, in turn, involves a comparison of prices and costs in a country, not a comparison of prices between countries." (Church and Wilkins 2014, paragraph 8.)

Verizon. We estimate the impact on the equity price of these wireless carriers arising from these news announcements through an "event-study" approach that relies upon regression analysis.[57]

This methodology, which is commonly used to assess damages in securities litigation and other settings,[58] provides an estimate of the impact on a company's stock price associated with the release of a particular piece of information. The analysis also controls for factors that generally affect stock prices over the same time period. Since the equity price of a company is, according to standard finance theory, the discounted value of the company's expected future profits (less the value of debt holders' claims on those profits), this approach allows us to assess the expected effect of Verizon's entry on the profits of Rogers, TELUS, and Bell.[59]

Next, given the estimated impact on incumbent carriers' future profits arising from the potential emergence of an additional nationwide carrier, we use an oligopoly market simulation model to assess the effects on equilibrium market prices and output. Our inputs into the market simulation are consistent with the financial market's prediction of the profit impacts induced by entry.[60]

The simulation model that we use is very similar to models that are used by antitrust agencies, including the Antitrust Division of the United States Department of Justice (U.S. DOJ) and the U.S. Federal Trade Commission, to assess the price impacts associated with mergers. Taken together, the event-study and market-simulation analyses let us estimate the impact on consumer surplus, producer profits, and total market surplus arising from the inclusion of an additional strong carrier.

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57 We are focused on the potential of entry by an additional wireless carrier that would cover a significant proportion of the Canadian population, across multiple provinces, and offer a voice, text and data service comparable to the offerings of Rogers, TELUS, and Bell. This is somewhat different from the regional entry initially facilitated by the 2008 AWS spectrum set-asides discussed in Section II.

58 In particular, this approach is commonly used in cases involving failures to disclose material information relating to a company's financial condition. See Mark L. Mitchell and Jeffry M. Netter, "The Role of Financial Economics in Securities Fraud Cases: Applications at the Securities and Exchange Commission," The Business Lawyer, February, 1994, pp. 545-599 (hereinafter "Mitchell and Netter 1994").

59 Brealey, Myers and Allen, Chapter 19, pp. 475-476.

60 In essence, the stock market reaction can be used to determine the "brand strength" of an additional competitor that would produce the associated profit impacts, using a model that assumes each competitor is setting prices to maximize its own profits given its rivals' choice of prices. That brand strength measure is useful in determining how much of the loss in profits experienced by incumbent carriers is attributable to reduced prices as opposed to reduced market share.

Of course, as previously mentioned, the emergence of an additional nationwide carrier may be facilitated by spectrum previously set aside to facilitate entry or expansion by a competitor. Reserving this spectrum for a new entrant, however, raises the costs faced by incumbent carriers in building and expanding out their own wireless LTE networks. In the latter part of this section, we provide estimates of these increased costs.

Taken together, these analyses let us characterize the inherent trade-off in wireless markets between economies of scale and other cost efficiencies resulting from fewer carriers, and the consumer benefits that result from having additional competition. In particular, it allows us to compare the increased cost from having less spectrum available for incumbent carriers against the economic benefits provided by additional competition.

A. Verizon Entry Event Study

In March 2013, press reports initially mentioned the possibility that U.S. carriers might consider entering the Canadian wireless market through the purchase of a smaller carrier, such as Wind Mobile. In the period between June and August 2013, several news reports were linked to Verizon's interest in potentially entering, and ultimately not entering, the Canadian wireless market. These are described in Table 6 below.[61] Around the time of the announcements, several sources, including TELUS, estimated that there was a 50% probability that Verizon would enter the market.[62]

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[61] The events shown in Table 6 were selected based on headline searches in Factiva and other news outlets, which yielded 17 news events related to the Canadian wireless industry or one of the three major Canadian wireless carriers. Of these events, we selected the six that pertained to the possibility of an entry by Verizon wireless. We also used headline searches in Bloomberg, L.P. to confirm the timing of each event and verify that news unrelated to Verizon's entry did not affect returns on the incumbents' stock prices.

[62] See "Likelihood of Verizon entering Canada's telecom market '50-50:' Telus CEO," Global News, August 22, 2013, available at: http://globalnews.ca/news/796489/likelihood-of-verizon-entering-canadas-telecom-market-50-50-telus-ceo/ (last visited February 27, 2014). See, also, Nicholas Van Praet, "Verizon entry into Canada could be 'catastrophic': Quebecor CEO," Financial Post, August 8, 2013, available at: http://business.financialpost.com/2013/08/08/verizon-entry-into-canada-could-be-catastrophic-quebecor-ceo/?__lsa=9d27-eca5 (last visited February 27, 2014).

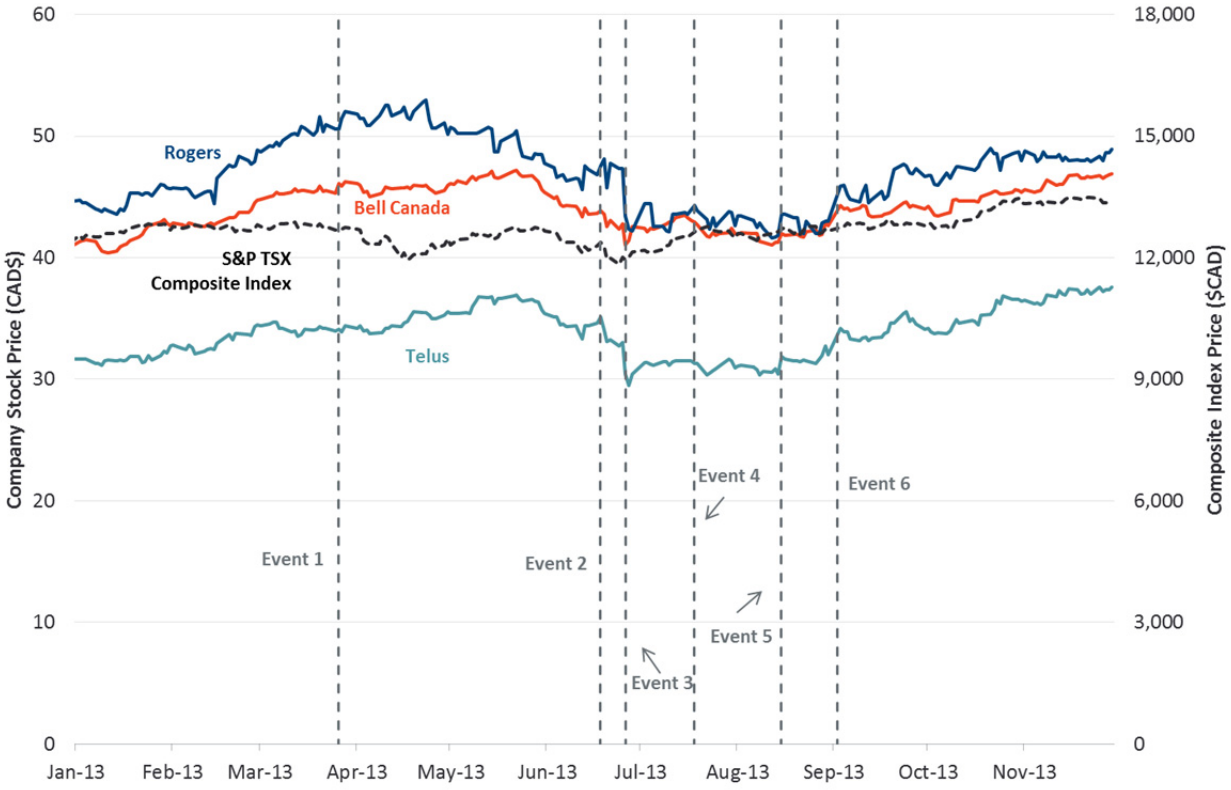
Table 6. Events used in Verizon Entry Event Study

Event	Date	Event Description	Expected Impact on Stock Prices
1	March 26, 2013	US carriers consider purchase of Wind Mobile.	Negative
2	June 18, 2013	Verizon considers entering Canadian wireless market.	Negative
3	June 26, 2013	Verizon offers to buy Wind Mobile.	Negative
4	July 18, 2013	Verizon earnings conference call confirms plans of Canadian expansion.	Negative
5	August 15, 2013	Verizon delays acquisition of Wind Mobile and Mobilicity.	Positive
6	September 2, 2013	Verizon decides not to enter Canadian wireless market.	Positive

Notes:
[1]: The TSX does not trade on September 2, 2013 (Labor Day). Event 6 is applied to September 3, 2013.

The releases of some of these pieces of news appear, on their face, to be associated with a reaction in the stock prices of Rogers, TELUS, and Bell, as indicated in Figure 11 below.

Figure 11. 2013 Toronto Stock Exchange Daily Prices, Adjusted for Dividends and Splits



Source: Yahoo Finance.

Economists have employed various techniques to ascertain whether the release of specific pieces of news have had a statistically, and economically, significant impact on the stock price of a

particular company. A common method is to estimate a statistical relationship between the daily rate of return for a specified company's stock and the daily rate of return for a relevant market index, such as the S&P/TSX Composite Index.[63] By also including indicator variables, known as dummy variables, to identify particular days when potentially relevant company specific news events occur, we can identify the potential effect of these events on the company's stock price.[64]

The equation expressing this relationship is:

$$r_{it} = \beta_0 + \beta_1 r_{mt} + \delta' D_{it} + \varepsilon_t,$$

where r_{it} is the daily rate of return for company i's stock price on day t, r_{mt} is the daily rate of return of the market index on day t, and D_{it} is a vector of dummy variables that indicate whether or not a given day is considered to be a "news" day for that particular company.[65] If a specified day is considered to be a "news" day, then there will be an indicator variable that will take on the value one for that day and zero for all other days in the data sample. In this case, the six news days are described above in Table 6.

The coefficients β_0, β_1, and the vector δ' in the above equation are estimated by the regression process to best fit the observed data. The coefficient β_1 indicates the "typical" relationship between the specified company's return and the return on the relevant market index.[66] For example, a coefficient of 0.5 indicates that every 1% increase in the market's (daily) rate of return is associated with a 0.5% increase in the specified company's rate of return.

The vector of coefficients δ' on the indicator variables estimate the size of any "abnormal" increase or decrease in the company's return associated with the release of a particular piece of news. An indicator might also represent multiple pieces of news that occur at nearly the same time. The residual, ε_t, represents the remaining variation in the daily return for company i's stock price that is not explained by the other variables and their respective coefficient estimates.

We applied the above empirical specification to the stock prices of Rogers, TELUS, and Bell. We regressed the daily return of each carrier's stock prices on the S&P/TSX Composite Index, along with indicator variables to assess whether "abnormal" positive or negative returns in these stocks were associated with the news events described in Table 6 above.

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63 In the following empirical exercise, we define the daily rate of return as the percent change in price from day $t-1$ to day t.

64 For a detailed description of the uses of event study analysis and an overview on its methodology, see A. Craig MacKinlay, "Event Studies in Economics and Finance," Journal of Economic Literature 35, March 1997, pp. 13-39, (hereinafter "MacKinlay 1997").

65 See, for instance, Mitchell and Netter 1994, p. 567; and MacKinlay 1997, p. 18.

66 This term is typically referred to as "beta" by financial analysts.

The regression results are presented in Table 7 below, based on a 1-day event window. The 1-day event window assumes the impact on stock prices of a particular news event occurs within a day of the announcement. Regression results for larger event windows, such as 2-day and 3-day, are contained in Appendix D and suggest similar outcomes. Using the 1-day event window, there is a negative and statistically significant impact on Rogers' TELUS' and Bell's stock prices associated with the news on June 26, 2013 that Verizon has offered to purchase Wind Mobile (event #3).

By contrast, there is a positive and statistically significant impact for Rogers, TELUS, and Bell associated with the news on August 15, 2013 that Verizon was delaying its acquisition of Wind Mobile and Mobilicity (event #5). The magnitude of these impacts varies from a 3.97% increase in Rogers' stock price, to a 1.53% increase in Bell's stock price, to a 4.50% increase in TELUS' stock price.

The news on September 2, 2013 that Verizon had decided not to enter the Canadian market (event #6) had a further positive and statistically significant impact on stock prices for the three carriers. This news is associated with an additional 6.41% increase in Rogers' stock price, 3.62% increase in Bell's stock price, and 6.42% increase in TELUS' stock prices.

Table 7. 2013 Event Study Regression Coefficients
One-Day Event Windows, Period 1/4/2012 to 9/4/2013

	Rogers	BCE	TELUS
S&P TSX Composite Index Daily Return (%)	0.423***	0.329***	0.409***
	(0.0826)	(0.0458)	(0.0610)
One-Day Window Event 1	-0.00131	0.0165**	0.00310
	(0.0121)	(0.00670)	(0.00892)
One-Day Window Event 2	0.0120	0.00201	0.0116
	(0.0121)	(0.00670)	(0.00893)
One-Day Window Event 3	-0.0803***	-0.0392***	-0.0786***
	(0.0121)	(0.00670)	(0.00892)
One-Day Window Event 4	0.00663	-0.00576	-0.00974
	(0.0121)	(0.00670)	(0.00892)
One-Day Window Event 5	0.0397***	0.0153**	0.0450***
	(0.0121)	(0.00670)	(0.00892)
One-Day Window Event 6	0.0641***	0.0362***	0.0642***
	(0.0121)	(0.00670)	(0.00893)
Constant	0.000456	0.000243	0.000486
	(0.000593)	(0.000329)	(0.000438)
Observations	420	420	420
R-squared	0.222	0.247	0.342

Notes:
[1]: Standard errors in parentheses.
[2]: Significance:*** p<0.01, ** p<0.05, * p<0.1

Taking the August 15, 2013 and September 2, 2013 news together, the impact of Verizon announcing that it would not enter the Canadian market was a 10.38% increase for Rogers' stock price, a 5.15% increase for Bell's stock price, and a 10.92% increase for TELUS' stock price. This suggests that the Canadian financial markets, and potentially analysts who assess the profit prospects of Canadian wireless firms, viewed Verizon's entry as having a substantial adverse effect on the profits of the three large incumbents. This effect would likely be due to erosion of the incumbent Canadian carriers' market share and the potential reduction of wireless prices.

B. Logit Model Price Predictions

The results of the event study suggest that stock market traders and investors believe that a sufficiently strong additional nationwide carrier would place greater competitive pressure on the incumbents. Consumers could benefit from the emergence of an additional nationwide carrier in two primary ways: prices likely would fall following successful entry, and the overall quality of service options likely would increase for at least some consumers.

This latter effect is captured by the "maverick" theory of harm in the U.S. DOJ's complaint suing to block the AT&T/T-Mobile merger in the United States.[67] An emerging competitor may do more than just compete on price in order to attract subscribers. It may offer new wireless plans and different service options not previously provided by the incumbents, which can lead to both market-stealing and market growth effects.

In this section, we use the results from the Verizon-entry event study and a logit demand model to predict the impact of an additional carrier in terms of its competitive effects on the wireless market. Our analysis estimates the effect on prices, market concentration, and wireless penetration associated with the emergence of an additional nationwide carrier. In addition, we derive the related change in consumer surplus, producer profits, and combined surplus.

1. Logit Model Description

The logit model is a widely used specification for consumer utility and demand, particularly in academic research in industrial organization and antitrust analysis.[68] It is particularly well-suited

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[67] Specifically, the U.S. DOJ cites T-Mobile as describing itself as the "challenger brand" that employs "disruptive pricing" plans. See Complaint at para. 3, U.S. DOJ v. AT&T, T-Mobile and Deutsch Telecom, No. 1:11-cv-01560, U.S. District Court of the District of Columbia, 2011, Available at http://www.justice.gov/atr/cases/f274600/274613.pdf (last visited February 28, 2014).

[68] See Gregory J. Werden and Luke M. Froeb, "The Effects of Mergers in Differentiated Products Industries: Logit Demand and Merger Policy," *The Journal of Law, Economics, & Organization,* Vol. 10, No. 2 (1994): 407-426 (hereinafter "Werden and Froeb 1994"); Steven T. Berry, "Estimating Discrete-Choice Models of Product Differentiation," *The RAND Journal of Economics*, Vol. 25, No. 2 (1994): 242-262 (hereinafter "Berry 1994"); and Aviv Nevo, "Mergers with Differentiated Products:

Continued on next page

to markets such as wireless services where significant potential exists for brand and product differentiation (including differentiation in product quality) across carriers. The logit model allows consumers to have different preferences for different competitors' products. We use the model in the context of the wireless market primarily for this reason.

Additionally, the form of the logit demand model that we are using for this simulation analysis has relatively parsimonious data requirements that align with the market information available.[69] The parameterization of the model depends primarily on information regarding carrier market shares and prices, along with some information on the price-cost margin facing individual carriers and estimates of the overall price sensitivity of demand for wireless services.

With this information in hand, the model assumes that firms are setting their prices to maximize profits, taking their competitors' prices as given, to recover the key model parameters. This assumption implies that observed prices and market shares are consistent with what is known in the economic literature as a Nash-Bertrand pricing equilibrium.

The model can then use information regarding a potential entrant's expected market presence to solve for a new set of equilibrium prices that would result from entry. In this case, we use the information derived from the event-study analysis described in Section IV.A above regarding the impact that entry is expected to have on rival profits.

From the logit model, we also can derive expected changes in market shares, wireless penetration, consumer surplus, producer profits, and combined surplus associated with the entry of a new wireless carrier. Specific details regarding the model are provided in Appendix B, including our methodology for calibrating the model and the data and assumptions that are relied upon.

Our analysis relies upon the cumulative predicted profit effects associated with Verizon's announcements not to enter the Canadian wireless market, as discussed above in Section IV.A,[70] assuming that the financial market believed Verizon's probability of entry was 50% before those announcements were made.[71]

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The Case of the Ready-to-Eat Cereal Industry," *The RAND Journal of Economics*, Vol. 31 No. 3 (2000): 395-421 (hereinafter "Nevo 2000").

69 Further refinements of the estimation of consumer demand would be possible with specific wireless plan information, possibly in the form of survey data that associates individuals' plan choices with plan characteristics.

70 These are Events 5 and 6 as reported in Section IV.A.

71 Our results are sensitive to the financial market's belief as to the probability of Verizon's entry at the time of each event. This probability substantially affects our derivation of the impact on competitor profits associated with the release of a particular piece of news.

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2. Competitive Effects of Entry

We generally predict substantial benefits accruing from the successful entry of a new nationwide wireless carrier. Nationwide, we predict that prices fall by about 2% and consumer surplus increases by $1 billion annually, representing approximately 5% of current industry revenues.

The magnitude of the consumer surplus increase is large compared to the relatively modest predicted price decrease.[72] The factors driving the increase in consumer surplus are a predicted increase in price competition faced by incumbents following entry, increased brand diversity, and an increase in wireless penetration associated with the emergence of an additional nationwide carrier.

As a consequence, we predict that the gap between Canada's penetration rates and those observed in other developed countries would shrink. We also predict substantial decreases in market concentration across the provinces and nationwide. All else equal, we expect this to lead to increased competitiveness between carriers and substantial non-price consumer benefits. In the sections below we explain these results in detail.

a. Share and Market Concentration

As discussed in Section II, Rogers, Bell, and TELUS together account for over 90% of subscriber market share in every province except for Manitoba and Saskatchewan (see Column 1 of Table 8 below). The combination of high market concentration for wireless carriers within each province, along with the nonuniformity of network coverage and subscriber share across the provinces, suggests that a large entrant may be able to significantly impact the competitiveness of

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If, in contrast to our 50% probability assumption, the market believed that Verizon's probability of entry was 100% before Events 5 and 6, the price and output effects, based on the stock price responses, would be approximately half of those reported. In other words, if there was a 100% probability that Verizon would enter, the implied profit effect of entry would be equal to the observed change in stock value. This assumes that there is no entry-related change in the value of firm's outstanding debt. Note, however, that we conservatively assume the same probability of entry by Verizon at the time that Events 5 and 6 occurred, even though the market's own reaction suggests that the probability of Verizon's entry was lower at the time of Event 6 when compared with Event 5.

Also, we argue here, similar to the discussion above, that the cumulative information regarding Verizon's decision not to enter the market, as provided by Events 5 and 6, provides the "least-noisy" information on the expected impact of Verizon's entry on incumbent profits.

72 As discussed later, the composition of the increase in consumer surplus deriving from increased brand diversity versus increased price competition is likely driven by certain characteristics of the logit demand model (see Appendix B). However, the overall increase in consumer surplus is unlikely to change substantially with alternative modelling assumptions.

the wireless market within each province and gain market share nationwide. For purposes of this analysis, we assume that an additional carrier can overcome whatever hurdles exist in becoming viable nationwide.

Table 8: Logit Model Share & Concentration Predictions

Province	Big 3 Incumbent Share		Entrant	HHI		
	Pre-Entry	Post-Entry	Share	Pre-Entry	Post-Entry	Δ
	[1]	[2]	[3]	[4]	[5]	[6]
Alberta	97%	89%	8%	3,606	3,133	-473
British Columbia	97%	88%	9%	3,446	2,937	-509
Manitoba	47%	42%	10%	4,004	3,397	-607
New Brunswick	100%	89%	11%	4,254	3,564	-690
Newfoundland and Labrador	100%	89%	11%	5,958	4,920	-1,038
Nova Scotia	100%	90%	10%	4,095	3,444	-650
Ontario	93%	84%	10%	3,188	2,698	-490
Prince Edward Island	100%	90%	10%	4,318	3,617	-701
Quebec	90%	81%	10%	2,725	2,301	-424
Saskatchewan	29%	26%	8%	5,322	4,683	-639
Canada	90%	82%	10%	2,771	2,372	-399

Notes:

[1]: Pre-entry percent of total subscribers for Rogers, Bell Group, and TELUS.

[2]: Post-entry percent of total subscribers for Rogers, Bell Group, and TELUS.

[3]: From logit model output of post-entry shares.

[4]-[5]: Herfindahl index calculated as the sum of the squares of the shares of each carrier. For HHI calculation purposes only, we assume 3 equally sized AWS carriers in each province.

[6]: [5] - [4].

The Verizon event study predicts that Verizon's entry would have reduced incumbent "variable profits"[73] by approximately 8%.[74] Incorporating this information into our simulation model, we predict that the new nationwide carrier would capture between 8% and 11% of subscribers across provinces, and 10% of Canadian wireless subscribers overall, as reported in Table 8 above.[75] This would decrease the combined subscriber share for the three nationwide incumbents by a range of 3% to 11% across the provinces and 9% nationwide.[76]

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[73] We consider "variable profits" as profits exclusive of fixed costs.

[74] See Table B-1.

[75] These results are partly driven by our modeling assumptions regarding market elasticities across provinces. For our base model, we assume that market elasticities range from -0.5 in Alberta to -1.0 in Quebec, modeled linearly between these two points based on average pre-entry prices. We conduct sensitivity analysis for these elasticity ranges. We consider a high-elasticity scenario where province

Continued on next page

Table 8 also contains our model's predictions of post-entry market concentration, as measured by the HHI, across provinces. The HHI analysis suggests that, within individual provinces, the wireless telephony market will remain highly concentrated in spite of significant decreases in the HHI of 444 to 1,038. However, given the high sunk costs and substantial fixed-cost scale economies involved in providing a wireless network, it would not be surprising that some degree of market concentration may be inherent to the provision of wireless services.

As a consequence of high market concentration, market consolidation among any of the major incumbent carriers could potentially produce significant consumer harm. The flip side of this, as suggested by the predictions of our market simulation analysis described below, is that successful entry by an additional nationwide carrier could significantly decrease concentration and lead to substantial gains in consumer surplus.

b. Changes in Surplus: Prices, Profits, and Consumer Surplus

In addition to predicting market shares upon entry, we also use the logit model to predict changes in prices, variable profits, and consumer surplus, consistent with a Bertrand-Nash equilibrium (as described more fully in Appendix B). Table 9 reports our predictions for prices. Incumbent prices fall by a range of 0.6% in Quebec to 2.5% in Newfoundland and Labrador. Nationwide, incumbent prices fall by 1.1%. We also predict that entrant prices will be somewhat lower than the incumbents' post-entry prices. As a consequence, the magnitude of the overall price decrease exceeds the size of the decrease in incumbents' prices, from 0.8% in Quebec to 3.3% in Newfoundland and Labrador, and 1.7% nationwide.

Continued from previous page

level elasticities range between -0.9 and -1.0, as well as a low-elasticity scenario where they range between -0.5 and -0.6. Across these ranges of elasticity values, we find generally robust results.

[76] Actual subscriber losses are between 6% and 7% for each incumbent nationwide (see Table C-5). Note that approximately 37% of the entrant's share gains come from market expansion (see Column 4 of Table 13). This is discussed in further detail below.

Table 9: Logit Model Price Predictions

Province	Incumbent Price			Entrant Price	Average Price	
	Pre-Entry ($) [1]	Post-Entry ($) [2]	%Δ [3]	($) [4]	Post-Entry ($) [5]	%Δ [6]
Alberta	73.50	72.46	-1.4%	64.48	71.79	-2.3%
British Columbia	63.56	62.92	-1.0%	57.75	62.44	-1.8%
Manitoba	59.31	58.62	-1.2%	56.42	58.40	-1.5%
New Brunswick	55.32	54.59	-1.3%	51.37	54.25	-1.9%
Newfoundland and Labrador	59.69	58.20	-2.5%	53.86	57.72	-3.3%
Nova Scotia	58.94	58.17	-1.3%	54.23	57.76	-2.0%
Ontario	61.87	61.29	-0.9%	57.82	60.93	-1.5%
Prince Edward Island	53.08	52.41	-1.3%	49.50	52.10	-1.8%
Quebec	51.95	51.64	-0.6%	50.64	51.54	-0.8%
Saskatchewan	63.30	62.22	-1.7%	61.27	62.15	-1.8%
Canada	61.47	60.80	-1.1%	57.06	60.44	-1.7%

Notes:
[1]: Share-weighted average price of all incumbent carriers. Source: Barclays Canadian Telecom Report November 2013, Figure 78.
[2]: Share-weighted average price of incumbent carriers from logit model output.
[3]: ([2] - [1]) / [1].
[4]: Share-weighted average price of new entrant, from logit model output.
[5]: Share-weighted average price of all carriers, including new entrant, from logit model output.
[6]: ([5] - [1]) / [1].

Table 10 reports our predictions on the changes in variable profits following successful entry of a new nationwide carrier, as well as the expected annual variable profits for the entrant.[77] The three nationwide incumbent carriers jointly lose almost $780 million annually following entry of the new carrier. This represents a decrease in variable profits of approximately 8% relative to pre-entry variable profit levels. Combined, all incumbents (nationwide and provincial) are predicted to lose $855 million annually, while the entrant is expected to earn $843 million annually, such that total industry lost variable profits are only about $12 million. This represents only about 0.1% of nationwide revenues (see Column 3 of Table 11).

[77] Note that our logit-based market simulation model is not well suited to making predictions about the level of *total* profits, as it does not rely on information related to fixed costs or the sunk costs associated with entry. See Section IV.C for further analysis of the impact of entry on the network costs incurred by incumbent carriers.

Table 10: Logit Model Effect of Entry on Variable Profits (in $ millions)

Province	Pre-Entry Variable Profit		Post-Entry Variable Profit			Post-Entry Δ Variable Profit		Post-Entry %Δ Variable Profit	
	Big 3	Other	Big 3	Other	Entrant	Big 3	Other	Big 3	Other
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
Alberta	2,033.16	44.64	1,868.28	40.44	134.40	-164.88	-4.20	-8.1%	-9.4%
British Columbia	1,389.24	32.40	1,276.68	29.52	108.84	-112.56	-2.88	-8.1%	-8.9%
Manitoba	144.48	208.80	132.36	193.32	27.12	-12.12	-15.48	-8.4%	-7.4%
New Brunswick	184.92	0.00	169.56	0.00	15.36	-15.36	0.00	-8.3%	
Newfoundland and Labrador	208.08	0.00	190.68	0.00	15.60	-17.40	0.00	-8.4%	
Nova Scotia	272.64	0.00	250.32	0.00	22.08	-22.32	0.00	-8.2%	
Ontario	3,893.52	232.32	3,569.76	211.56	361.32	-323.76	-20.76	-8.3%	-8.9%
Prince Edward Island	33.00	0.00	30.24	0.00	2.76	-2.76	0.00	-8.4%	
Quebec	1,263.24	120.12	1,161.84	110.16	131.64	-101.40	-9.96	-8.0%	-8.3%
Saskatchewan	88.20	388.92	81.00	366.72	24.48	-7.20	-22.20	-8.2%	-5.7%
Canada	9,510.48	1,027.20	8,730.72	951.72	843.60	-779.76	-75.48	-8.2%	-7.3%

Notes:
[1]: Pre-entry sum of variable profits for all Rogers, Bell Group, and TELUS.
[2]: Pre-entry sum of variable profits for other incumbent carriers.
[3]-[5]: Post-entry sum of variable profits predicted from logit model.
[6]-[7]: Post-entry change in variable profits predicted from logit model.
[8]: [6] / [1].
[9]: [7] / [2].

We also predict substantial increases in consumer surplus following entry. We model the change in consumer surplus as the amount of *compensating variation*, or lump sum cash payment, needed to make consumers just as happy with the new bundle of goods and prices as they were with the old bundle and prices and the cash payment.

The logit model predictions for consumer surplus are summarized in Table 11. We predict incremental increases in consumer surplus ranging from $3.5 million in Prince Edward Island to approximately $427.2 million in Ontario.[78] Across provinces and nationwide, the improvement in consumer surplus is significant, ranging from 4.4% as a share of wireless revenues in Quebec to 7.8% in Newfoundland and Labrador.[79] Nationwide, we predict a $1 billion annual increase in consumer surplus, which is equivalent to 5.1% of nationwide wireless revenues.

[78] See Column 6 of Table 11. It should be noted that the logit model will always predict an increase in consumer surplus following entry, although the magnitude will vary depending on the degree of substitutability between rival products, market elasticities, and market size.

[79] See Column 8 of Table 11. The initial pre-entry level of consumer surplus is undetermined in the logit model, so we follow convention by comparing the change in consumer surplus to the pre-entry level of market revenues. For further discussion, see Werden and Froeb 1994, pp. 411-412.

Table 11: Logit Model Annual Surplus Predictions

Province		Δ Variable Profits		Δ Consumer Surplus					
	Pre-Entry Revenue ($ Millions) [1]	Value ($ Millions) [2]	Share of Revenue [3]	Increased Price Competition ($ Millions) [4]	Entrant Brand Value ($ Millions) [5]	Price Δ + Entrant Value ($ Millions) [6]	Price Δ % of Total [7]	Share of Revenue [8]	Total Surplus Share of Revenue [9]
Alberta	3,391.1	-34.7	-1.0%	49.7	129.8	179.5	28%	5.3%	4.3%
British Columbia	2,805.5	-6.6	-0.2%	29.4	105.0	134.4	22%	4.8%	4.6%
Manitoba	650.9	-0.5	-0.1%	7.8	26.2	34.0	23%	5.2%	5.1%
New Brunswick	354.0	0.0	0.0%	4.6	14.8	19.3	24%	5.5%	5.5%
Newfoundland and Labrador	279.8	-1.8	-0.6%	6.8	15.0	21.8	31%	7.8%	7.2%
Nova Scotia	500.6	-0.2	0.0%	6.4	21.2	27.6	23%	5.5%	5.5%
Ontario	8,007.0	16.8	0.2%	79.6	347.6	427.2	19%	5.3%	5.5%
Prince Edward Island	66.5	0.0	0.0%	0.8	2.6	3.5	24%	5.2%	5.2%
Quebec	3,352.4	20.3	0.6%	21.1	126.7	147.8	14%	4.4%	5.0%
Saskatchewan	650.5	-4.9	-0.8%	11.3	23.8	35.0	32%	5.4%	4.6%
Canada	20,058.4	-11.6	-0.1%	217.4	812.8	1,030.2	21%	5.1%	5.1%

Notes:
[1]: (Average revenue per user-month) x (Number of subscribers) x 12.
[2], [4], [5]: From logit model output of post-entry shares and prices (annualized).
[3]: [2] / [1].
[6]: [4] + [5].
[7]: [4] / [6].
[8]: [6] / [1].
[9]: ([2] + [6]) / [1].

Finally, consumer surplus gains exceed incumbent variable profit losses by approximately $175 million annually ($1,030 million in consumer surplus gains less $855 million in incumbent losses).[80] Including the entrant's benefits, we predict that total surplus, as the sum of consumer and producer surplus (variable profits), would increase. As a fraction of pre-entry revenues, total surplus increases by a range of 4.3% in Alberta to 7.2% in Newfoundland and Labrador. Nationwide, we predict an increase in total surplus of approximately $1 billion annually, representing about 5% of Canada's approximately $20 billion in annual wireless services revenue.[81]

80 See Section IV.C for details.

81 In the next section, we estimate that, by having less spectrum available to them as a result of entry, incumbents will have to invest in additional cell sites at a cost of approximately $370 million over five years (in present value terms). That cost, which is not factored into the logit model analysis described above, would be recovered in 2.5 years of the annual net surplus gains of $175 million that we have otherwise identified.

Therefore, on balance, this analysis suggests that entry will produce positive "external benefits"—that is, the benefits to consumers less the losses to competitors from entry are positive. This is to be expected as markets become more efficient and dead weight losses are reduced. On this basis, if entry is privately profitable, then it would be viewed as beneficial on balance to the wireless industry.

c. Market Growth and Wireless Penetration

The increases in consumer and total surplus described above are arguably large. We have conducted sensitivity analysis of our logit-based oligopoly simulation model across various assumptions, and found them to be generally robust.[82] However, given the underlying assumptions of consumer demand in the logit model, it is perhaps not surprising that we predict large benefits from entry.[83] In Table 13 below, we summarize the impact of entry on the amount of new subscribers (*i.e.*, the "market growth" effect) and the loss of subscribers experienced by incumbents (*i.e.*, the "market-stealing" effect). Table 11 above also identifies the change in consumer surplus attributable purely to entry-related decreases in incumbent prices (see Column 4). It also compares this increasing consumer surplus to the incremental increase in consumer surplus explained by the addition of the new brand into the market (Column 5).

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[82] See Appendix B for further details.

[83] It is a well-known feature of the logit model that each new product introduced occupies an entirely new slice of product space, in spite of however similar the product may be (on characteristics observable to the researcher) to any incumbent products. This is often described as the *Red Bus – Blue Bus* problem, or the *Independence of Irrelevant Alternatives* assumption that is inherent to the logit model. For further details, see Moshe Ben-Akiva and Steven Lerman *Discrete Choice Analysis*, The MIT Press (1985), pp. 51-52 and 108-111. See also Daniel Ackerberg and Marc Rysman "Unobserved Product Differentiation in Discrete Choice Models: Estimating Price Elasticities and Welfare Effects," *RAND Journal of Economics*, Vol. 36, No. 4 (Winter 2005): pp. 771-788.

Table 12: Logit Model Predictions of Entry-Related Changes in Market Penetration

Province	Population	Pre-Entry		Post-Entry	
		Subscribers	Penetration	Subscribers	Penetration
	[1]	[2]	[3]	[4]	[5]
Alberta	3,923,160	3,844,697	98%	3,941,650	100%
British Columbia	4,558,597	3,678,332	81%	3,801,314	83%
Manitoba	1,254,320	914,525	73%	952,371	76%
New Brunswick	756,560	533,299	70%	558,856	74%
Newfoundland and Labrador	527,619	390,649	74%	414,307	79%
Nova Scotia	944,403	707,830	75%	739,044	78%
Ontario	13,457,345	10,784,716	80%	11,207,554	83%
Prince Edward Island	145,250	104,333	72%	109,329	75%
Quebec	8,107,419	5,377,651	66%	5,604,719	69%
Saskatchewan	1,094,350	856,329	78%	888,949	81%
Canada	34,769,023	27,192,361	78%	28,218,093	81%

Notes:
[1]: Canada Statistics.
[2]: Calculated based on Canadian provincial population from Canada Statistics and mobile penetration and coverage data from Canadian Radio-television and Telecommunications Commission.
[3]: [2] / [1].
[4]: From logit model output of post-entry shares.
[5]: [4] / [1].

One metric for examining market performance is the wireless penetration rate. As discussed in Section II above, Canada has low penetration rates compared to other countries.[84] Table 12 summarizes the logit model penetration rate predictions.

In the current market, province level penetration rates range from a low of 66% in Quebec to a high of 98% in Alberta. The penetration rate across all of Canada is 78%, approximately 26 percentage points lower than the United States.[85]

[84] See Figure 2.

[85] The pre-entry penetration rate reported here relies on subscriber information for 2012 from CRTC 2013 and population data from Stats Canada, and differs by one percentage point from the fourth quarter numbers reported in Global Wireless Matrix 2013. See Appendix B for further details on the calculation of the penetration rate pre- and post-entry.

Based on the estimates arising from our logit-based market simulation model, the successful entry of an additional nationwide wireless carrier would increase the nationwide penetration rate to 81%. Province-level penetration rates would increase by a range of two percentage points in Alberta (to 100%) to five percentage points in Newfoundland and Labrador (to 79%). While these increases are nontrivial, they are also modest, and the resulting penetration rates are still considerably lower than those in many other developed countries.[86]

Table 13: Logit Model Entry: Market-Stealing vs. Market Growth

Province		Post-Entry		
	Pre-Entry Subscribers [1]	Incumbent Subscriber Loss [2]	Entrant Subscribers [3]	% Subscribers from Incumbents [4]
Alberta	3,844,697	234,934	331,887	71%
British Columbia	3,678,332	229,400	352,382	65%
Manitoba	914,525	53,963	91,809	59%
New Brunswick	533,299	33,346	58,903	57%
Newfoundland and Labrador	390,649	21,874	45,532	48%
Nova Scotia	707,830	43,725	74,939	58%
Ontario	10,784,716	718,091	1,140,929	63%
Prince Edward Island	104,333	6,451	11,447	56%
Quebec	5,377,651	358,065	585,133	61%
Saskatchewan	856,329	37,162	69,782	53%
Canada	27,192,361	1,737,011	2,762,743	63%

Notes:
[1]: Calculated based on Canadian provincial population from Canada Statistics and mobile penetration and coverage data from Canadian Radio-television and Telecommunications Commission.
[2], [3]: From logit model output of post-entry shares.
[4]: [2] / [3].

In addition to the impact of entry on penetration rates, we show in Table 13 how the entry of an additional nationwide carrier affects both the number of new subscribers and the number of subscribers lost by incumbent carriers to the entrant. Incumbents are predicted to lose more than 1.7 million subscriptions annually across all provinces. We predict that the entrant would take on almost 2.8 million subscriptions nationwide, with approximately 63% of its subscription base captured from incumbents and the remainder captured via market growth.

In terms of consumer surplus, the effects of price competition are significantly smaller than the market-stealing effect would suggest. Increased price competition following entry of a new

[86] See Figure 2.

nationwide carrier leads only to a modest decrease in incumbent prices (of 1.1% nationwide), as mentioned previously.

Incumbent price decreases benefit existing subscribers directly. The price decreases would also induce new customers, previously priced out of the market for wireless telephony, to purchase subscriptions. The increased consumer surplus from the decrease in incumbent prices (as shown in Column 4 of Table 11), range from almost $1 million (annually) in Prince Edward Island to almost $80 million in Ontario. In aggregate across all provinces, consumer surplus increases by almost $220 million from incumbent price decreases induced by greater price competition following entry.

Consumers also benefit from the added brand diversity of the entrant's product, as shown in Column 5 of Table 11. Across the provinces, consumers value the increased brand diversity by a range of almost $3 million annually in Prince Edward Island to almost $350 million annually in Ontario. Nationwide, the increased brand diversity increases consumer surplus by over $800 million annually. These values are considerably larger than the benefit of lower incumbent prices caused by increased price competition.

The disparity in effect between brand diversity and increased price competition is, to some extent, at least partially an artifact of the logit demand model. Alternative modeling assumptions (and particularly more complete data) may serve to limit the extent of brand diversity resulting from entry, including the expansion in the number of subscribers. However, as the service offerings of the wireless providers become closer substitutes for one another, we would expect more intense price competition and greater price reductions from entry. This would result in greater consumer benefits from reduced prices than are predicted by our model.

Nonetheless, entry is likely to lead to increased non-price competition, including potentially new wireless plans and different service options not previously provided by the incumbents. Such an effect from entry would be consistent with the explanation for Canada's relatively low penetration levels that there is less product diversity than in other countries. To the extent that the logit model (imperfectly) captures that potential, the distinction between price effects and brand effects in the consumer surplus calculation may not be as important as the overall estimated increase in consumer surplus generally.

C. Costs of Network Buildout in Relation to Spectrum Allocation

The consumer and other surplus gains associated with the entry of a strong nationwide carrier must be balanced against the possibility that the entry of an additional nationwide wireless carrier will significantly affect the costs of incumbent carriers and that entry might not be profitable.

Due to the nature of wireless networks, an additional nationwide carrier would increase Canadian wireless industry expenditures in at least two ways. First, an emerging new carrier would incur substantial sunk and fixed costs to create a nationwide wireless network, which could theoretically render entry unprofitable (or imply that additional entry must be subsidized).

Additional research outside of the scope of the current analysis would be required to make this determination.[87] These start-up costs are not explicitly included in the logit-based market simulation analysis presented above.

Second, reserving spectrum for an additional nationwide carrier implies that incumbents would have less spectrum potentially available to expand their own network capacity.[88] There is an inherent trade-off between additional expenditure on cell sites and the ability to use additional wireless broadband spectrum. Consequently, incumbents would likely have to build more cell sites as a result of having less spectrum to use.[89]

Our analysis in this section focuses on the second effect of a new entrant. We consider the ongoing additional cell sites and related expenditures required for LTE expansion by each of the incumbents.[90] The number of additional cell sites required by each carrier to expand its LTE network depends in large part on the overall growth in LTE data traffic, as well as the impact that the entry of an additional nationwide carrier would have on the availability of additional spectrum for incumbents and the required network capacity of the incumbents.

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87 One analyst estimates that entry by an additional nationwide carrier would cost between $2.5 and $4.5 billion. See, Richard Choe, "Canadian Communications," JP Morgan, September 20, 2013, p. 22, (hereinafter "JP Morgan September 20, 2013"): "A new entrant could spend at least $2.5-4.5b to enter Canada." Figures are in Canadian dollars. At the upper bound of this analyst's cost estimate, the post-tax IRR of the logit-model-predicted profit stream for the entrant (see Table 10), over 10 years and assuming no salvage value and the same inflation and tax assumptions as in Section 3 (see Table 4), would be at least 8.45%.

88 Network operators face a trade-off between adding spectrum and adding cell sites to their networks to meet increasing demands for wireless capacity. As described in more detail in Appendix C, additional cell sites allow the same band of spectrum to be further reused, thereby allowing more total users to be served on a fixed amount of spectrum. As an alternative to adding cell sites, if the spectrum is available, carriers could deploy additional spectrum frequencies to their existing cell sites. More spectrum allows for lower capital investment in cell sites and lower average network costs per subscriber.

89 An additional carrier could also potentially result in higher costs due to fewer economies of scale for network equipment and handsets. Given the substantial ecosystem of equipment for deploying AWS spectrum, this potential effect is likely to be minimal.

90 We do not address the potential expansion of the carriers HSPA+ networks, because we expect that all future spectrum available in Canada will be used to deploy LTE or some future technology. Now that LTE is being deployed, the trade-off between new spectrum and additional cell sites is less relevant to the HSPA+ network.

For the purposes of our analysis, we assume that the LTE wireless network capacity grows by roughly 25% per year between 2012[91] and 2017. This growth includes both expansion of LTE coverage and increases in LTE capacity where the network already exists.[92] In order to accommodate this LTE expansion, incumbent carriers will likely invest in a combination of additional cell sites and, if available, additional spectrum to increase the capacity of cell sites.

The availability of additional spectrum for incumbents, however, likely depends on whether there is a new entrant. At the time of the AWS spectrum auction in 2008, Industry Canada set aside 40 MHz of AWS spectrum for new entrants.[93] Similarly, Industry Canada reserved 10 or 12 MHz of prime 700 MHz spectrum for new entrants in that auction.[94] Whether spectrum originally set aside for new entrants is ultimately available for incumbent LTE expansion depends in part on whether there is a strong new entrant and, if there is no new entrant, whether incumbents are allowed to acquire and utilize this spectrum.[95]

We have created a model that estimates how the costs of achieving the projected LTE buildout differs depending on the amount of additional spectrum available to each incumbent, where the amount of available spectrum is potentially influenced by the presence or absence of an additional nationwide carrier.[96] The emergence of an additional nationwide carrier also affects network buildout costs in our model because incumbents lose subscribers and usage volume to the entrant, potentially reducing their need for additional wireless capacity.

Our model estimates network buildout for each incumbent, incorporating carrier and province specific factors, including spectrum holdings as of 2012, the number of LTE cell sites owned by each carrier as of 2012, LTE coverage as of 2012 and expected coverage expansion, likely network sharing arrangements between carriers, and the costs of cell towers.

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91 As described in detail in Appendix C.A, our network model is based on incumbent LTE networks as of the end of 2012.

92 See Appendix C.A.1 for more details on our LTE coverage and Appendix C.B.1 for buildout and growth assumptions.

93 See Appendix C.B.3 for details of the AWS auction set-asides.

94 See Appendix C.B.3 for details of the 700 MHz auction rules.

95 Although the five year moratorium on selling set aside AWS licenses to incumbents has expired, Canadian officials likely would still have to allow for the transferring of control to incumbents of spectrum originally set aside for new entrants. For instance, in 2013 Industry Canada blocked TELUS' repeated attempts to purchase Mobilicity and its spectrum. See "Canada again blocks Telus-Mobilicity spectrum deal," Reuters, October 31, 2013, available at: http://www.reuters.com/article/2013/10/30/us-telecoms-minister-idUSBRE99T0YG20131030 (last visited February 4, 2014).

96 Our model considers a small set of feasible scenarios that may occur between 2012 and 2017 in order to give a range of estimates for the added costs to the incumbents. We recognize that there are many other possible scenarios that may unfold, and that the potential cost savings to additional spectrum is likely to extend beyond 2017.

We identify the likely coverage areas for each carrier's LTE network as of the end of 2012 and estimate the distribution of existing LTE cell sites. Next, we use this information to project where additional cell site expansion would be required, depending on the growth in data traffic and spectrum available.

This analysis suggests that, in the absence of any new spectrum, and without a new nationwide entrant, each of the incumbent carriers would have to build additional cell sites between 2012 and 2017. As shown below in Table 15, we expect that Rogers would need just over 18,000 cell sites, TELUS would need just over 15,000 cell sites, and Bell would need nearly 8,000 cell sites.

Based on the cost of installing and operating a cell site for 10 years,[97] the total cost of these additional cell sites is between $1.6 billion and $3.6 billion in present value terms (as of 2014), depending on the carrier.

1. Effect of an Additional Nationwide Carrier

If an additional nationwide carrier were to enter the wireless market, the spectrum set aside in auctions would be more likely to remain in the hands of new entrants.[98] As illustrated in the logit model discussed above, the new entrant also would take market share from the incumbents, which would result in lower traffic growth for each incumbent carrier.[99]

Based on its current spectrum holdings, Table 14 summarizes the additional cell sites required for each of the three nationwide incumbent carriers between 2012 and 2017, assuming there is a new entrant. With no additional spectrum and a new nationwide entrant in the market, we estimate that Rogers would have to build almost 18,000 cell sites, TELUS would have to build over 15,000 sites, and Bell would likely have to build just over 7,000 cell sites between 2012 and 2017.[100] The present value as of 2014 of these additional cell sites is roughly $3.5 billion for Rogers, $3.4 billion for TELUS, and around $1.5 billion for Bell.

It is likely, however, that even if there is a new entrant, existing carriers will be able to acquire and deploy at least an additional 10 MHz of spectrum by 2015.[101] By deploying an additional 10

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97 See Appendix C.B.4 for details of the initial build and operating costs of a cell site.

98 This does not necessarily mean that the nationwide new entrant would acquire the entirety of set aside spectrum. What happens to the remaining set-aside spectrum is not relevant for our analysis. There is an implicit assumption, however, that if there is a strong new entrant, Canadian regulators will be less likely to allow transfers of set-aside spectrum to incumbents.

99 As explained in Appendix C.B.2 we base our assumptions regarding incumbents' lost market share on the results of the logit model.

100 As described in Appendix C.A.1, our model incorporates some of the characteristics of the roaming agreements between TELUS and Bell.

101 For instance, incumbent carriers are likely to acquire additional spectrum in the 700 MHz auction.

MHz in 2015, we estimate that Rogers would likely save over 2,300 cell sites, while TELUS and Bell would each save more than 1,200 cell sites by 2017. In terms of the avoided costs of building and operating these cell sites, Rogers would save just under $600 million, and TELUS and Bell would each save in excess of $300 million in present value (2014) dollars.[102]

These amounts are somewhat less than these carriers paid for spectrum in the recent 700 MHz auction. However, they are not inconsistent with what they paid for two reasons. First, while our model only estimates the cell site savings through 2017, it is likely that additional cell site savings would result as each carrier's network continues to expand beyond this time frame. Second, spectrum is not depleted when used, and at the end of any value modeling period, the carriers would still own the spectrum, which would still retain considerable value.

[102] This analysis does not consider the cost associated with acquiring the spectrum.

Table 14. Summary of Incumbent Carrier Cell Site Investments, Assuming Emergence of an Additional Nationwide Carrier

		Total [A]	Savings from Spectrum [B]
Bell			
Number of Cell Sites			
Base	[1]	7,330	
Base + 10 MHz	[2]	6,035	1,295
Value of Cell Sites			
Base	[3]	$1,485M	
Base + 10 MHz	[4]	$1,167M	$318M
TELUS			
Number of Cell Sites			
Base	[1]	15,028	
Base + 10 MHz	[2]	13,795	1,233
Value of Cell Sites			
Base	[3]	$3,420M	
Base + 10 MHz	[4]	$3,107M	$314M
Rogers			
Number of Cell Sites			
Base	[1]	17,666	
Base + 10 MHz	[2]	15,347	2,319
Value of Cell Sites			
Base	[3]	$3,522M	
Base + 10 MHz	[4]	$2,952M	$570M

Notes and Sources:

[A][1] - [A][4]: Source: The Brattle Group Network Analysis.
[B][2]: [A][1] - [A][2].
[B][4]: [A][3] - [A][4].

2. Effect of No Additional Nationwide Carrier

As shown in Table 15, based on their current spectrum holdings, if no new additional nationwide carrier emerges, each incumbent would have to build an additional 8,000 to 18,000 cell sites by 2017, costing between $1.6 and $3.7 billion in present value (2014) terms. Since there would be no new nationwide entrant to take market share, growth in traffic for each carrier is slightly higher. Consequently, each incumbent's baseline requirement for additional cell sites is higher in the absence of entry, because each incumbent retains a greater share of the market and its wireless traffic volume is relatively higher in this case.

Similar to the case of a new entrant, we expect that each of the nationwide incumbent carriers will be able to acquire and deploy at least 10 MHz of additional spectrum by 2015. By acquiring and deploying an additional 10 MHz of 700 MHz spectrum in the 2014 auction, Rogers could save approximately 2,600 cell sites and nearly $700 million in avoided costs, while TELUS and Bell could each save between 1,400 and 1,500 cell sites and just under $400 million in avoided costs in present value (2014) terms.[103]

If there is no new nationwide entrant and the spectrum set aside for new entrants were available to incumbent carriers, each incumbent might acquire and deploy additional spectrum. For illustrative purposes, we estimate the potential cost savings to carriers deploying an additional 10 MHz or 20 MHz of spectrum.[104]

If each incumbent were to receive an additional 10 MHz of set aside spectrum, in addition to the 10 MHz of spectrum we expect they would deploy in either case, we estimate Rogers could save over 3,500 cell sites, or nearly $900 million in (2014) present value, relative to its current spectrum holdings. TELUS and Bell would each avoid the cost of building and operating between 1,800 and 1,900 cell sites. This represents nearly $500 million in cost savings for each company in present value (2014) terms, if they could obtain this additional spectrum, as compared to maintaining their current spectrum holdings.

Table 15 suggests that the additional savings from an additional 10 MHz of spectrum (i.e., 20 MHz of set aside spectrum and 10 MHz of spectrum the carriers deploy in either case) would be fairly low by 2017. However, we would expect savings to continue if the carriers had to further expand their network capacity after 2017.

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[103] This analysis does not consider the cost associated with acquiring the spectrum.

[104] This is broadly consistent with there currently being 40 MHz set aside from the AWS auction and another 10 or 12 MHz from the 700 MHz auction. Individual incumbent carriers might acquire 10 MHz or 20 MHz of spectrum. For the purposes of this illustrative example, for all additional spectrum deployed, we assume that the maximum cell site radii and capacity continue to be fixed based on AWS spectrum. This assumption is discussed in further detail in Appendix C.B.3.

Table 15. Summary of Incumbent Carrier Cell Site Investments, Assuming No Additional Nationwide Carrier

		Total [A]	Savings from Spectrum [B]
Bell			
Number of Cell Sites			
Base	[1]	7,591	
Base + 10 MHz	[2]	6,084	1,507
Base + 20 MHz	[3]	5,687	1,904
Base + 30 MHz	[4]	5,672	1,919
Value of Cell Sites			
Base	[5]	$1,556M	
Base + 10 MHz	[6]	$1,167M	$389M
Base + 20 MHz	[7]	$1,076M	$481M
Base + 30 MHz	[8]	$1,072M	$484M
TELUS			
Number of Cell Sites			
Base	[1]	15,321	
Base + 10 MHz	[2]	13,915	1,406
Base + 20 MHz	[3]	13,503	1,818
Base + 30 MHz	[4]	13,421	1,900
Value of Cell Sites			
Base	[5]	$3,501M	
Base + 10 MHz	[6]	$3,127M	$374M
Base + 20 MHz	[7]	$3,025M	$475M
Base + 30 MHz	[8]	$3,005M	$495M
Rogers			
Number of Cell Sites			
Base	[1]	18,129	
Base + 10 MHz	[2]	15,504	2,625
Base + 20 MHz	[3]	14,593	3,536
Base + 30 MHz	[4]	14,534	3,595
Value of Cell Sites			
Base	[5]	$3,647M	
Base + 10 MHz	[6]	$2,965M	$682M
Base + 20 MHz	[7]	$2,754M	$892M
Base + 30 MHz	[8]	$2,741M	$906M

Notes and Sources:

[A][1] - [A][8]: Source: The Brattle Group Network Analysis.
[B][2]: [A][1] - [A][2].
[B][3]: [A][1] - [A][3].
[B][4]: [A][1] - [A][4].
[B][6]: [A][5] - [A][6].
[B][7]: [A][5] - [A][7].
[B][8]: [A][5] - [A][8].

3. Total Expenditure Savings

As described above, regardless of whether an additional nationwide carrier emerges, incumbents can save substantial capital and operating expenditures by deploying additional spectrum. The availability of additional spectrum, however, depends on whether the spectrum originally set aside for new entrants is utilized by an additional nationwide carrier or is eventually deployed by the incumbents.

To assess the added expenditures required by incumbents if an additional nationwide carrier emerges, we compare scenarios where a new carrier emerges and incumbents can only deploy an additional 10 MHz of spectrum, with scenarios in which an additional nationwide carrier does not emerge and each incumbent can deploy an additional 20 MHz or 30 MHz of spectrum that would include 10 MHz or 20 MHz of the spectrum originally set aside for new entrants.

This analysis, as described in Table 16 below, suggests that Rogers could save approximately 750 cell sites by 2017 if they were able to deploy an additional 10 MHz of spectrum, as opposed to having an additional nationwide carrier emerge. In the same scenarios, TELUS would save approximately 290 cell sites, while Bell would save an estimated 350 cell sites by 2017. The associated cost savings amounts to between $80 million and $200 million in present value terms. In total, this represents over $370 million in cost savings across the three carriers in present value terms (based on the number of avoided cell sites by 2017). For the purposes of comparing this magnitude to the surplus from the logit modeling, this represents just under 2% of total 2014 estimated industry revenues.[105]

The cost savings from deploying an additional 20 MHz of spectrum, as opposed to having an additional nationwide carrier emerge, is relatively similar based on estimates of the number of avoided cell sites through 2017. Assuming, however, that carriers must continue to increase network capacity as a result of expanding demand for wireless services, we would expect to see additional savings arising beyond 2017 from access to additional spectrum.

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[105] Based on total estimated savings for all three carriers from receiving an additional 10 MHz of spectrum and not having a new entrant (e.g., Base + 20 scenario with no new carrier compared to Base + 10 with a new carrier) of $370 million. We compare these to Canadian wireless industry estimated revenues of $22.15 billion in 2014, the last year available (see "Canada – Wireless Communications - Insights, Statistics and Forecasts," Paul Budde Communication Pty Ltd, February 20, 2014, p. 8, Table 8).

Table 16. Summary of Savings to No New Entrant Scenarios

		Cell Sites	Value
Bell			
Emerging National Carrier			
Base	[1]	7,330	$1,485M
Base + 10 MHz	[2]	6,035	$1,167M
No Fourth National Carrier			
Base + 20 MHz	[3]	5,687	$1,076M
Base + 30 MHz	[4]	5,672	$1,072M
Savings Over Base to No Fourth National Carrier			
Base + 20 MHz	[5]	1,643	$409M
Base + 30 MHz	[6]	1,658	$413M
Savings Over Base + 10 to No Fourth National Carrier			
Base + 20 MHz	[7]	348	$91M
Base + 30 MHz	[8]	363	$95M
Telus			
Emerging National Carrier			
Base	[1]	15,028	$3,420M
Base + 10 MHz	[2]	13,795	$3,107M
No Fourth National Carrier			
Base + 20 MHz	[3]	13,503	$3,025M
Base + 30 MHz	[4]	13,421	$3,005M
Savings Over Base to No Fourth National Carrier			
Base + 20 MHz	[5]	1,525	$395M
Base + 30 MHz	[6]	1,607	$415M
Savings Over Base + 10 to No Fourth National Carrier			
Base + 20 MHz	[7]	292	$81M
Base + 30 MHz	[8]	374	$101M
Rogers			
Emerging National Carrier			
Base	[1]	17,666	$3,522M
Base + 10 MHz	[2]	15,347	$2,952M
No Fourth National Carrier			
Base + 20 MHz	[3]	14,593	$2,754M
Base + 30 MHz	[4]	14,534	$2,741M
Savings Over Base to No Fourth National Carrier			
Base + 20 MHz	[5]	3,073	$768M
Base + 30 MHz	[6]	3,132	$782M
Savings Over Base + 10 to No Fourth National Carrier			
Base + 20 MHz	[7]	754	$198M
Base + 30 MHz	[8]	813	$211M

Notes and Sources:

[1] - [4]: Source: The Brattle Group Network Analysis.
[5]: [1] - [3].
[6]: [1] - [4].
[7]: [2] - [3].
[8]: [2] - [4].

V. Summary

A. Conclusions

In addition to international metrics that are consistent with high levels of returns, we estimate that at least two of Canada's nationwide wireless carriers are earning above-normal rates of return on their wireless investments. We find that TELUS' pre-tax IRR through 2030 is in the range of 13.8% to 17.9%, as compared to a pre-tax WACC of 11.5%. With respect to Rogers, we find an after-tax wireless IRR through 2030 of 12.7%, as compared to an 8.1% competitive return.

These "positive" or "excess" economic profits imply that Canadian wireless carriers could be exercising market power and, therefore, that there would be potential competitive benefits from an additional nationwide carrier. We evaluate those potential competitive effects using a two stage approach to simulate the market outcomes arising from emergence of a strong additional carrier.

As a first step, we analyze the stock market reaction to announcements by Verizon that it was initially considering expanding into Canada, and that it had decided to forgo the opportunity at that time. We estimate that the combined effect of Verizon's two announcements that it would not expand into Canada was 10.4% for Rogers' stock price, 5.2% for Bell's stock price, and 10.9% for TELUS' stock price. On its own, this analysis suggests that the financial market believed that entry by an additional carrier would have considerable effects on incumbent profits.

In the second stage, we use a logit demand model to simulate the price and market effects of an additional carrier, assuming that the effect on incumbent profitability was consistent with results from the Verizon event study. We predict that prices would fall by almost 2%, while penetration would increase to 81% nationwide. Total surplus would increase by 5% of industry revenues.

The consumer and other surplus gains associated with an additional strong nationwide carrier must be balanced against the additional capital investment required to accommodate an entrant. In addition to incurring the cost of deploying its own wireless network, an additional nationwide carrier would likely increase wireless network costs for existing incumbents by diverting valuable spectrum from their deployments. If they were able to deploy an additional 10 MHz of spectrum, we estimate that Rogers could avoid constructing roughly 750 cell sites, Bell could avoid constructing approximately 350 cell sites, and TELUS could avoid constructing approximately 290 cell sites. The savings through 2017 would amount to between $80 million and $200 million for each carrier in present value terms.

B. Caveats

Although we find evidence that Canadian wireless carriers may possess market power and that there could be substantial surplus gains to added competition, further analysis is necessary to

determine whether the Canadian wireless industry could sustain an additional nationwide carrier. In order to be viable, the new carrier must expect to earn at least a normal return on the investment required to create an additional nationwide network. The analyses undertaken do not directly address whether the new or emerging nationwide carrier could expect to earn at least a normal return on its investment. Moreover, our analyses do not examine whether incumbents would continue to earn normal or above normal profits with additional entry into the Canadian wireless market.

C. Next Steps

Our entry simulation uses carrier specific information, including shares, ARPU, and margins, to calibrate a logit model. We also rely on the financial market reaction to a specific potential entrant, which was Verizon in this case. This offers a somewhat stylized view of market competition based on the effects of specific announcements regarding potential entry by Verizon.

In order to more fully evaluate the competitive effects of entry, another approach would be to look at the effects of past events, such as the 2008 AWS spectrum auction, that had a structural impact on the Canadian wireless industry. Variation in market structure across provinces may provide a basis for performing a formal analysis to quantify the consumer benefits associated with market entry or changes in market structure. Unfortunately, the duration and granularity of publicly available data is insufficient for this approach.[106]

Similarly, the network cost analysis would benefit from more detailed data on carrier networks and costs. Currently publicly available data provides limited information on the distribution of cell sites by carrier and specific coverage areas. More detailed and updated information regarding cell sites and their locations would increase the accuracy of our modeling of the trade-off between spectrum availability and expenditures on cell sites. It would also provide opportunities to model other aspects of scale and network economies in this industry.[107]

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[106] In order to parse out these effects, one would need to examine disaggregated pricing and subscriber data, across the time period both before and after the events. Performing this analysis would require detailed data on carrier level prices, individual wireless service plan characteristics, subscribers, and costs. Such data would need to be disaggregated by carrier, province or sub-provincial geographies, and year to leverage information on differences in firm market shares, spectrum holdings, capital expenditures, and market concentration across provinces and over time to estimate the effects of changes in wireless market structure on market performance.

[107] In order to improve this analysis, one would need additional annual information on the number of carrier cell sites by disaggregated regional area (for instance, census divisions or subdivisions) and type of technology available (HSPA, LTE).

Appendix A. Profitability Analysis

A. TELUS IRR Calculation

Our analysis finds "lifecycle" return rates (IRRs) for TELUS range from about 11.6% to 16.8% when extending the period of analysis to 2018 and 13.8% to 17.9% when extending the analysis to 2030.[108] Importantly, these percentages are calculated in terms of nominal, pre-tax returns. Ideally, we also would calculate a TELUS IRR in nominal, after-tax terms. However, the historical development of (and financial reporting for) this operation complicate any estimations of the corporate income taxes needed for an after-tax return calculation.[109]

1. Construction of TELUS Free Cash Flow

To calculate this range of IRRs, we start by estimating annual pre-tax FCFs invested in, and earned by, TELUS' wireless operation for 1988-2012. As shown in Tables A-1 and A-2, we estimate these FCFs by subtracting each year's capital and other cash investments from EBITDA for that year. Then, as explained in Section 3, we extend FCFs beyond 2012 by assuming that FCFs remain constant in real terms.

The complicated history of TELUS results in the reported wide range of nominal, pre-tax IRRs. Specifically, TELUS as it stands today is the product of:

- the 1990 privatization of Alberta Government Telephone Commission (AGT), a crown corporation, to create TELUS Corporation;
- the acquisition in 1995 of Edmonton Telephone Corporation (ED TEL) from the City of Edmonton;
- the 1998 merger of TELUS with BC Tel, the telecommunications firm that served British Columbia, to form BCT.TELUS, subsequently renamed "TELUS";
- the 2000-2001 acquisition of QuebecTel Group, a provider of wireline and wireless telecommunications, information technology, and other services in Quebec; and

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108 As noted in Section III.A of this report, we also calculate IRRs through 2012 and 2024.

109 For example, TELUS management projected the tax loss carry-forwards that it acquired from Clearnet to be worth between $500 million and $800 million in net present value terms. (See TELUS, "Leading The Convergence of Revolution," August 2000, available at http://secfilings.nyse.com/filing.php?doc=1&attach=ON&ipage=1231582&rid=23 (last visited February 28, 2014).)

- TELUS' acquisition in late 2000 of Clearnet Communications, a nationwide cellular telephone provider, for $6.6 billion in cash, stock, and (net) assumed debt.[110]

When estimating IRRs for TELUS Wireless, we treat each of these transactions as follows:

- When TELUS was formed, 2.7% of Total Net Assets came from AGT's Cellular subsidiary.[111] We treat this amount ($79.2 million) as the cash invested to start TELUS Wireless operations in 1990. We add another $16.1 million of other possible Capex to this figure, to avoid calculating an IRR that is distorted upwards.[112]
- We assume that 25% of the $468 million paid by TELUS to acquire ED TEL was related to ED TEL's wireless operations. See Table A-3.
- We estimate EBITDA, Capex, and FCF amounts realized in BC Tel's Wireless segment for each year from 1988 through 1997, and then combine these annual cash flow amounts to the corresponding annual value for TELUS Wireless during these years.
- We assume that wireless operations accounted for approximately 25% of the $869.4 million that TELUS paid during 2000 and 2001 to acquire QuebecTel. We approximate this from a Proxy statement circulated to QuebecTel shareholders in May 2000. See Table A-3.

Finally, as explained below, we construct two alternative measures of the amount that TELUS "invested" when it acquired Clearnet Communications. These alternatives provide a lower and upper bound to our estimates and explain the four percentage point return range mentioned above (*i.e.*, 13.8% versus 17.9% for the 2030 IRR).

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110 This total $6.6 billion acquisition "price" is not disclosed in TELUS' Annual Reports. According to TELUS' Report for 2000, TELUS acquired the outstanding shares of Clearnet for $4.133 million, comprised of $2.179 million in cash and $1.954 in TELUS stock. This Report also notes that TELUS assumed Clearnet's long-term debt. According to TELUS, the assumption of Clearnet's net long-term debt brought the total transaction price to an "announced value" of $6.6 billion. See TELUS, "TELUS and Clearnet to create Canada's largest wireless company," Press Release, August 8, 2000, available at http://about.telus.com/community/english/news_centre/news_releases/blog/2000/08/21/telus-and-clearnet-to-create-canadas-largest-wireless-company (last visited February 28, 2014).

111 See TELUS, Annual Report 1991, p. 11.

112 This approach is comparable to the method used by C&W 2013 to measure Rogers Wireless' "Capex" at inception. See C&W 2013, Appendix A.

Table A-1. TELUS Wireless Real, Pre-Tax IRR ($ M)
"Lower Bound"

Year	BC TEL Nominal Cash Flows			TELUS Nominal Cash Flows Excluding Clearnet			Clearnet Acquisition	BC TEL, TELUS, and Clearnet Combined Nominal Cash Flows			
	EBITDA	Capex	Other Cash Investments	EBITDA	Capex	Other Cash Investments	Total Transaction Value	EBITDA	Capex	Other Cash Investments	Pre-Tax Free Cash Flow (nominal $)
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
1988	1.8	11.1	0.0				0.0	1.8	11.1	0.0	-9.2
1989	8.9	18.3	0.0				0.0	8.9	18.3	0.0	-9.5
1990	21.7	37.2	0.0	0.0	16.1	79.2	0.0	21.7	53.2	79.2	-110.7
1991	29.8	29.0	0.0	5.3	20.5	0.0	0.0	35.1	49.5	0.0	-14.3
1992	42.2	29.0	0.0	11.5	19.3	0.0	0.0	53.7	48.3	0.0	5.4
1993	59.5	44.0	0.0	25.0	15.0	0.0	0.0	84.5	59.0	0.0	25.5
1994	86.1	48.0	0.0	43.0	27.4	0.0	0.0	129.1	75.4	0.0	53.7
1995	117.8	77.0	0.0	65.9	50.8	116.9	0.0	183.7	127.8	116.9	-60.9
1996	144.2	86.0	0.0	127.2	73.3	0.0	0.0	271.4	159.3	0.0	112.1
1997	177.9	102.2	0.0	188.0	122.7	0.0	0.0	365.9	224.9	0.0	141.0
1998				375.3	192.6	0.0	0.0	375.3	192.6	0.0	182.7
1999				379.4	165.2	0.0	0.0	379.4	165.2	0.0	214.2
2000				307.4	222.9	146.1	6,600.0	307.4	222.9	6,746.1	-6,661.6
2001				294.0	643.0	427.2		294.0	643.0	427.2	-776.2
2002				530.0	455.1	4.6		530.0	455.1	4.6	70.3
2003				817.0	359.9	0.0		817.0	359.9	0.0	457.1
2004				1,144.0	354.7	0.0		1,144.0	354.7	0.0	789.3
2005				1,445.0	404.8	0.0		1,445.0	404.8	0.0	1,040.2
2006				1,752.9	427.4	0.0		1,752.9	427.4	0.0	1,325.5
2007				1,906.0	551.0	0.0		1,906.0	551.0	0.0	1,355.0
2008				2,005.0	548.0	882.0		2,005.0	548.0	882.0	575.0
2009				1,933.0	770.0	0.0		1,933.0	770.0	0.0	1,163.0
2010				2,020.0	463.0	0.0		2,020.0	463.0	0.0	1,557.0
2011				2,186.0	508.0	81.0		2,186.0	508.0	81.0	1,597.0
2012				2,467.0	711.0	84.0		2,467.0	711.0	84.0	1,672.0
2013											1,705.4
2014											1,739.5
2015											1,774.3
2016											1,809.8
2017											1,846.0
2018											1,882.9
2019											1,920.6
2020											1,959.0
2021											1,998.2
2022											2,038.2
2023											2,078.9
2024											2,120.5
2025											2,162.9
2026											2,206.2
2027											2,250.3
2028											2,295.3
2029											2,341.2
2030											2,388.0
IRR											
1988 - 2012:											6.8%
1988 - 2018:											11.6%
1988 - 2024:											13.2%
1988 - 2030:											13.8%

Notes and Sources:

[1] - [3]: BC Telecom Annual Financial Data.

[4] - [6]: TELUS Annual Financial Data.

[7]: http://about.telus.com/community/english/news_centre/news_releases/blog/2000/08/21/telus-and-clearnet-to-create-canadas-largest-wireless-company

[8]: [1] + [4].

[9]: [2] + [5].

[10]: [3] + [6] + [7].

[11]: [8] - [9] - [10].

2013-2030 values grow with 2% assumed inflation.

Table A-2. TELUS Wireless Real, Pre-Tax IRR ($ M)
"Upper Bound"

	BC TEL Nominal Cash Flows			TELUS Nominal Cash Flows Excluding Clearnet			Clearnet	BC TEL, TELUS, and Clearnet Combined Nominal Cash Flows			
Year	EBITDA	Capex	Other Cash Investments	EBITDA	Capex	Other Cash Investments	Total Cash Outflows	EBITDA	Capex	Other Cash Investments	Pre-Tax Free Cash Flow (nominal $)
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
1988	1.8	11.1	0.0				0.0	1.8	11.1	0.0	-9.2
1989	8.9	18.3	0.0				0.0	8.9	18.3	0.0	-9.5
1990	21.7	37.2	0.0	0.0	16.1	79.2	0.0	21.7	53.2	79.2	-110.7
1991	29.8	29.0	0.0	5.3	20.5	0.0	0.0	35.1	49.5	0.0	-14.3
1992	42.2	29.0	0.0	11.5	19.3	0.0	0.0	53.7	48.3	0.0	5.4
1993	59.5	44.0	0.0	25.0	15.0	0.0	24.0	84.5	59.0	24.0	1.5
1994	86.1	48.0	0.0	43.0	27.4	0.0	168.5	129.1	75.4	168.5	-114.8
1995	117.8	77.0	0.0	65.9	50.8	116.9	137.4	183.7	127.8	254.3	-198.3
1996	144.2	86.0	0.0	127.2	73.3	0.0	165.5	271.4	159.3	165.5	-53.4
1997	177.9	102.2	0.0	188.0	122.7	0.0	765.0	365.9	224.9	765.0	-624.0
1998				375.3	192.6	0.0	568.7	375.3	192.6	568.7	-386.0
1999				379.4	165.2	0.0	571.3	379.4	165.2	571.3	-357.1
2000				307.4	222.9	146.1	395.0	307.4	222.9	541.1	-456.6
2001				294.0	643.0	427.2		294.0	643.0	427.2	-776.2
2002				530.0	455.1	4.6		530.0	455.1	4.6	70.3
2003				817.0	359.9	0.0		817.0	359.9	0.0	457.1
2004				1,144.0	354.7	0.0		1,144.0	354.7	0.0	789.3
2005				1,445.0	404.8	0.0		1,445.0	404.8	0.0	1,040.2
2006				1,752.9	427.4	0.0		1,752.9	427.4	0.0	1,325.5
2007				1,906.0	551.0	0.0		1,906.0	551.0	0.0	1,355.0
2008				2,005.0	548.0	882.0		2,005.0	548.0	882.0	575.0
2009				1,933.0	770.0	0.0		1,933.0	770.0	0.0	1,163.0
2010				2,020.0	463.0	0.0		2,020.0	463.0	0.0	1,557.0
2011				2,186.0	508.0	81.0		2,186.0	508.0	81.0	1,597.0
2012				2,467.0	711.0	84.0		2,467.0	711.0	84.0	1,672.0
2013											1,705.4
2014											1,739.5
2015											1,774.3
2016											1,809.8
2017											1,846.0
2018											1,882.9
2019											1,920.6
2020											1,959.0
2021											1,998.2
2022											2,038.2
2023											2,078.9
2024											2,120.5
2025											2,162.9
2026											2,206.2
2027											2,250.3
2028											2,295.3
2029											2,341.2
2030											2,388.0

IRR

1988 - 2012:	14.0%
1988 - 2018:	16.8%
1988 - 2024:	17.6%
1988 - 2030:	17.9%

Notes and Sources:

[1] - [3]: BC Telecom Annual Financial Data.
[4] - [6]: TELUS Annual Financial Data.
[7]: Clearnet Communications Annual Financial Data.
[8]: [1] + [4].
[9]: [2] + [5].
[10]: [3] + [6] + [7].
[11]: [8] - [9] - [10].
2013-2030 values grow with 2% assumed inflation.

Table A-3. Derivation of Wireless Share Assumptions for TELUS' QuebecTel and ED Tel Transactions

ED TEL

	Value ($ M)	Share of Total (%)
1995 TELUS Edmonton Assets	452.0	75%
1995 TELUS Mobility Assets	151.9	25%
1995 Total Assets	603.9	100%

QuebecTel

	Scotia Capital, Impact of Sensitivity on DCF Analysis ($ M)		Segment % of Total Impact	
	Low	High	Low	High
Local	6.5	7.1	43.6%	43.3%
Long Distance	4.8	5.3	32.2%	32.3%
Wireless	3.6	4	24.2%	24.4%
Total	14.9	16.4	100.0%	100.0%

Memo: Discount Rate (nominal, after-tax WACC) used in Scotia Capital DCF Analysis of QuebecTel: 8.25% - 8.50%.

Sources: TELUS 1996 Annual Report, pg. 39; NOTICE AND MANAGEMENT PROXY CIRCULAR, QuebecTel Group, pages B-8 and B-9.

2. TELUS Wireless IRR Calculations

As noted above, we calculate a range of TELUS Wireless IRRs based on the alternative treatments of TELUS' Clearnet acquisition. Of TELUS' transactions, the Clearnet acquisition was the most significant in terms of its effects on economic profitability of TELUS Wireless.

As noted in TELUS' 2000 Annual Report, "[t]he acquisition of Clearnet allowed TELUS Mobility to transform itself overnight from a predominantly regional wireless service provider to the largest national wireless company in Canada".[113] As can be seen in Table A-1, the $6.6 billion acquisition "price" of Clearnet dwarfed TELUS' previous wireless related capital spending and "other cash investments" through 2000.

Table A-1 shows our calculation of 11.6% to 13.8% as a lower-bound for TELUS' wireless IRRs, depending on the period of analysis. This calculation is based on including TELUS' entire $6.6 billion acquisition "price" as a cash investment in 2000.

[113] See TELUS, Annual Report 2000, p. 33.

In principle, some of this $6.6 billion transaction price might have reflected some "capitalized monopoly power." This would essentially be the present value of excess profits that TELUS expected to gain by acquiring Clearnet. As explained by Church and Ware, the inclusion of such capitalized "monopoly profits" can distort the acquiring firm's calculated returns downward and hide its exercise of market power.[114]

In addition, when TELUS acquired Clearnet, it also acquired Clearnet's spectrum holdings, which included a 30 MHz PCS license that Canada granted to Clearnet in 1995 at no cost.[115] Although the license was effectively free to Clearnet, this spectrum asset had value, reflecting spectrum's scarcity as a resource. The spectrum license, which was essential for TELUS' provision of nationwide wireless service, likely represented some portion of the value paid by TELUS for Clearnet. This could be included as an "investment" by TELUS. In principle, it is also possible that some of the spectrum portion of this value reflected the capitalized value of a less than fully competitive marketplace.

Accordingly, Table A-2 shows our upper bound, where we calculate a 16.8% to 17.9% real, pre-tax IRR for TELUS' wireless operations. This calculation is based on estimating EBITDA, Capex, and FCFs for Clearnet's wireless operations for each year from 1993 through the third quarter of 2000, and then combining these annual cash flow amounts to the corresponding annual values for TELUS' wireless operations during those years. This treats Clearnet as if it had been part of TELUS during the entire period. This upper-bound IRR assumes that TELUS (like Clearnet), obtained Clearnet's wireless spectrum "for free."

Although the actual IRR is likely between these upper and lower bounds, the upper bound, using Clearnet's cash flows, is probably closer to the actual IRR. The value of the 30 MHz PCS license that Clearnet received in 1995 was likely a relatively small fraction of the $6.6 billion transaction value that TELUS paid, as compared to the capitalized monopoly profits. This would suggest that the upper bound approach would provide a more accurate estimate.

3. TELUS WACC Calculation

The appropriate competitive benchmark for TELUS' wireless, pre-tax IRRs is the pre-tax WACC.[116] As explained in Section III.A of this report, to assess whether TELUS is earning

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[114] Church and Ware, Industrial Organization: A Strategic Approach (2000), pp. 434-435.

[115] See Industry Canada, "A Brief History of Cellular and PCS Licensing," October 2004, p. 2, available at http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08408.html (last visited February 28, 2014). In total, 14 PCS companies were awarded licenses, two of which were 30 MHz nationwide licenses. The other nationwide PCS license was granted to Microcell.

[116] See, for example, Dennis W. Carlton and Jeffrey M. Perloff, Modern Industrial Organization, 4th Edition (2005), pp. 245-246. See also, Jeffrey Church and Roger Ware, Industrial Organization: A Strategic Approach (2000), Chapter 12.

above-normal profits, we need to compare these IRRs with the cost of capital that investors required to finance TELUS' wireless business. To assess this relationship, Table A-4 shows our calculation of TELUS' pre-tax weighted-average cost of capital (WACC). These are derived, in part, using Bloomberg data.

When gauging whether a firm's IRRs have exceeded a cost of capital benchmark, both the IRR and the benchmark must reflect the same treatment of inflation (*i.e.*, real versus nominal) and corporate income taxes (*i.e.*, pre- versus after-tax). Under standard cost of capital methods, the WACC for a firm is estimated in terms of nominal, after-tax values. However, for the purposes of comparing with the TELUS pre-tax IRRs developed above, we construct a pre-tax WACC.

To derive pre-tax costs of capital, we "gross up" TELUS' after-tax WACC for each year by dividing by (1 – tax rate), using tax rates that approximate TELUS' statutory corporate income tax rate as of that year. In general, this adjustment will overstate the pre-tax cost of capital for TELUS, which will cause us to understate the magnitude of any above-normal returns earned by TELUS.[117] As a result of data limitations, we rely on a WACC for TELUS' consolidated operations, not specifically for its wireless operations. This is unlikely to bias our results because wireless represents a majority of TELUS' earnings.[118]

To create an average WACC that can be compared to an IRR, we blend these pre-tax WACCs into averages that cover the time periods for which we calculate IRRs. We determine the weights for each year's WACC by adjusting TELUS' annual Capex (and other investments) for inflation to obtain a measure of "real" Capex in each year. The weight applied to the pre-tax cost of capital in a given year is then the real capital expenditure (and other investments) in that year divided by the total real capital expenditure (and other investments) over the relevant time period.[119]

In all cases, the pre-tax IRR exceeds the pre-tax WACC for the associated time horizon, implying that TELUS is earning above-normal returns on its wireless investments.

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[117] In standard finance theory, the value of an investment equals its after-tax cash flows discounted at the after-tax cost of capital. Ideally, the pre-tax cost of capital would be the discount rate that equates pre-tax cash flows to this same investment value. However, our calculated pre-tax cost of capital is larger than this "ideal" rate, because it does not consider tax savings realized through the firm's use of depreciation on its capital investments (which reduces a firm's tax liability).

[118] We estimated about 90% in our analysis of the impact of Verizon's decision not to enter the Canadian market.

[119] This approach may underestimate the average WACC if the time horizon of the investments is taken into account and the annual WACC estimates are declining over time. We do not believe this potential underestimate is very large in magnitude, specifically when compared to our overestimate of the pre-tax WACC.

Table A-4. Blended Average WACC for TELUS

Year	TELUS Wireless Nominal Capex and Other Cash Investments ($ '000)	Deflator (1986 = 1.000)	TELUS Wireless Real Capex and Other Cash Investments ($ '000)	Estimated TELUS Ex-Ante Nominal After-Tax WACC	Estimated TELUS Corporate Income Tax Rate	Estimated TELUS Ex-Ante Nominal Pre-Tax WACC
	[1]	[2]	[3]	[4]	[5]	[6]
1988	$11,076	1.113	$9,948	12.41%	49.8%	24.7%
1989	$18,324	1.172	$15,630	12.11%	45.0%	22.0%
1990	$132,390	1.241	$106,707	13.35%	44.0%	23.8%
1991	$49,473	1.287	$38,433	12.80%	44.0%	22.9%
1992	$48,300	1.315	$36,724	10.86%	44.0%	19.4%
1993	$83,021	1.337	$62,097	10.05%	44.0%	18.0%
1994	$243,866	1.340	$181,982	11.82%	44.0%	21.1%
1995	$381,256	1.363	$279,645	10.52%	44.0%	18.8%
1996	$324,839	1.393	$233,217	10.48%	44.5%	18.9%
1997	$989,924	1.404	$705,209	8.85%	44.5%	16.0%
1998	$761,292	1.418	$536,987	8.06%	44.5%	14.5%
1999	$736,498	1.455	$506,208	8.17%	44.5%	14.7%
2000	$763,999	1.502	$508,806	6.06%	44.0%	10.8%
2001	$1,070,750	1.512	$707,971	5.13%	41.7%	8.8%
2002	$459,700	1.570	$292,825	4.17%	38.6%	6.8%
2003	$359,900	1.602	$224,589	5.69%	36.6%	9.0%
2004	$354,700	1.637	$216,724	5.79%	35.3%	8.9%
2005	$404,800	1.671	$242,278	6.50%	36.1%	10.2%
2006	$427,400	1.699	$251,596	6.97%	35.8%	10.9%
2007	$551,000	1.739	$316,825	7.87%	35.2%	12.1%
2008	$1,430,000	1.759	$812,816	9.02%	32.7%	13.4%
2009	$770,000	1.783	$431,951	8.83%	32.3%	13.0%
2010	$463,000	1.825	$253,763	8.06%	30.5%	11.6%
2011	$589,000	1.866	$315,571	7.49%	28.0%	10.4%
2012	$795,000	1.882	$422,426	5.60%	26.4%	7.6%
2013 - 2030	$13,446,504		$5,950,559	7.23%	26.4%	9.8%
Percentage of 1986-2012 Total						
1988-1999:	30.9%		35.2%			
2000-2012:	69.1%		64.8%			
Blended Average WACC						
1988-2012:				7.7%		12.8%
1988-2018:				7.6%		12.2%
1988-2024:				7.6%		11.8%
1988-2030:				7.5%		11.5%

Notes and Sources:

[1]: Appendix Table A-2, columns [9] + [10].
2013 - 2030 values assume investments equal the 2010-2012 average in 2013 and then grows with 2% expected annual inflation.

[2]: Church and Wilkins 2013, Table 4.

[3]: [1] / [2].
2013 - 2030 values assume investments equal the 2010-2012 average and stays constant in real terms.

[4]: Source for 200 - 2012: Bloomberg, L.P.
WACC for 1988 - 1999 equal to the Government of Canada 10 Year Benchmark Bond Yields, plus a fixed differential equal to the average difference between WACC and 10 Year Benchmark Bond Yields over 2001 - 2012.
WACC for 2013 - 2030 assumed to equal average real WACC for 2010-2012 (5.1%) adjusted for 2.% inflation.
Blended Average WACC calculated as a weighted average of [4], using the real investments in [3] as weights.

[5]: Assumed equal to Rogers' statutory tax rates.

[6]: [4]/(1- [5]).
Blended Average WACC calculated as a weighted average of [6], using the real investments in [3] as weights.

B. Rogers Wireless IRR Calculation

1. Rogers Wireless Free Cash Flows and IRR Calculation

As shown in Table A-5, our calculation of IRRs for Rogers' wireless division uses a similar approach to that which we used for TELUS. Additional information, however, allows us to estimate Rogers' returns in nominal, after-tax terms. This after-tax calculation includes the following steps:

- Estimating earnings before interest and taxes (EBIT) for Rogers Wireless over time, by subtracting each year's depreciation and amortization expense from the wireless EBITDA;
- Adjusting each year's wireless EBIT to account for Canada's tax-loss carry forward rules, including expiration rules that have varied over time, yielding taxable income;[120] and
- Using the statutory tax rates shown in Rogers' Annual Reports to compute the wireless segment's contribution to taxes due.

Again, we estimate three different IRRs, assuming that Rogers' 2012 financial performance is maintained through 2018, 2024, and 2030, respectively. This assumption essentially treats Rogers' 2012 cash flows as a "steady state" for the future, where these cash flows only increase with the rate of inflation after 2012. We also calculate the IRR through 2012 for purposes of comparison with C&W 2013. With these adjustments—a decrease from the tax adjustment and an increase from the inflation adjustment—the estimated nominal, after-tax IRRs equal 11.2%, 12.3%, and 12.7% for the period from 1988 through 2018, 2024, and 2030, respectively.

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[120] As explained on p. 27 of Rogers' Annual Report for 2004, "[a]s part of the acquisition of Microcell, the Company acquired tax loss carry forwards of approximately $1.75 billion against which a full valuation allowance has been recorded at the date of acquisition." When calculating Rogers' taxable income, we add these "acquired" carry forwards to the balance available to Rogers as of the start of calendar 2005.

Our calculation assumes that the benefits of tax losses incurred during the startup of Rogers' wireless business could not be realized immediately (either via a carry-back or by their application to then-year taxable income). This assumption leads to a lower calculated IRR.

Table A-5. Estimated Nominal, After-Tax Rogers Wireless IRR (Nominal $ '000)

Year	EBITDA	Capex and Other Investments	Pre-Tax Free Cash Flow	Depreciation and Amortization Expense	EBIT	Application of Tax Loss Carry Forwards	Taxable Income	Statutory Income Tax Rate	Income Taxes	After-Tax Free Cash Flow
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
1986	-$12,804	$62,814	-$75,618	$3,141	-$15,945	$0	$0	52.3%	$0	-$75,618
1987	-$1,771	$52,651	-$54,422	$5,773	-$7,544	$0	$0	52.3%	$0	-$54,422
1988	$17,797	$91,646	-$73,849	$6,856	$10,941	$10,941	$0	49.8%	$0	-$73,849
1989	$30,026	$261,328	-$231,302	$31,005	-$979	$0	$0	45.0%	$0	-$231,302
1990	$76,156	$495,568	-$419,412	$92,484	-$16,328	$0	$0	44.0%	$0	-$419,412
1991	$99,605	$162,456	-$62,851	$112,630	-$13,025	$0	$0	44.0%	$0	-$62,851
1992	$129,452	$240,731	-$111,279	$148,681	-$19,229	$0	$0	44.0%	$0	-$111,279
1993	$198,600	$181,400	$17,200	$169,552	$29,048	$29,048	$0	44.0%	$0	$17,200
1994	$289,900	$182,403	$107,497	$188,031	$101,869	$33,061	$68,808	44.0%	$30,276	$77,221
1995	$315,600	$185,600	$130,000	$208,440	$107,160	$0	$107,160	44.0%	$47,150	$82,850
1996	$351,100	$553,800	-$202,700	$214,823	$136,277	$0	$136,277	44.5%	$60,643	-$263,343
1997	$395,700	$604,700	-$209,000	$255,958	$139,742	$0	$139,742	44.5%	$62,185	-$271,185
1998	$395,100	$301,300	$93,800	$274,264	$120,836	$0	$120,836	44.5%	$53,772	$40,028
1999	$422,300	$420,250	$2,050	$285,458	$136,842	$0	$136,842	44.5%	$60,895	-$58,845
2000	$410,900	$526,000	-$115,100	$334,619	$76,281	$0	$76,281	44.0%	$33,564	-$148,664
2001	$411,900	$1,051,300	-$639,400	$382,608	$29,292	$0	$29,292	41.7%	$12,215	-$651,615
2002	$527,700	$564,600	-$36,900	$457,133	$70,567	$0	$70,567	38.6%	$27,239	-$64,139
2003	$727,600	$411,900	$315,700	$518,599	$209,001	$0	$209,001	36.6%	$76,494	$239,206
2004	$950,400	$1,946,900	-$996,500	$497,674	$452,726	$0	$452,726	35.3%	$159,812	-$1,156,312
2005	$1,337,000	$585,000	$752,000	$624,000	$713,000	$713,000	$0	36.1%	$0	$752,000
2006	$1,987,000	$684,000	$1,303,000	$630,000	$1,357,000	$1,037,000	$320,000	35.8%	$114,560	$1,188,440
2007	$2,589,000	$822,000	$1,767,000	$560,000	$2,029,000	$0	$2,029,000	35.2%	$714,208	$1,052,792
2008	$2,806,000	$1,937,000	$869,000	$588,000	$2,218,000	$0	$2,218,000	32.7%	$725,286	$143,714
2009	$3,042,000	$905,000	$2,137,000	$660,000	$2,382,000	$0	$2,382,000	32.3%	$769,386	$1,367,614
2010	$3,173,000	$1,010,000	$2,163,000	$648,000	$2,525,000	$0	$2,525,000	30.5%	$770,125	$1,392,875
2011	$3,036,000	$1,192,000	$1,844,000	$674,000	$2,362,000	$0	$2,362,000	28.0%	$661,360	$1,182,640
2012	$3,063,000	$1,123,000	$1,940,000	$703,388	$2,359,612	$0	$2,359,612	26.4%	$622,937	$1,317,063
2013	$3,124,260	$1,145,460	$1,978,800	$717,456	$2,406,804	$0	$2,406,804	26.4%	$635,396	$1,343,404
2014	$3,186,745	$1,168,369	$2,018,376	$731,805	$2,454,940	$0	$2,454,940	26.4%	$648,104	$1,370,272
2015	$3,250,480	$1,191,737	$2,058,744	$746,441	$2,504,039	$0	$2,504,039	26.4%	$661,066	$1,397,677
2016	$3,315,490	$1,215,571	$2,099,918	$761,370	$2,554,119	$0	$2,554,119	26.4%	$674,288	$1,425,631
2017	$3,381,800	$1,239,883	$2,141,917	$776,598	$2,605,202	$0	$2,605,202	26.4%	$687,773	$1,454,143
2018	$3,449,435	$1,264,680	$2,184,755	$792,130	$2,657,306	$0	$2,657,306	26.4%	$701,529	$1,483,226
2019	$3,518,424	$1,289,974	$2,228,450	$807,972	$2,710,452	$0	$2,710,452	26.4%	$715,559	$1,512,891
2020	$3,588,793	$1,315,773	$2,273,019	$824,132	$2,764,661	$0	$2,764,661	26.4%	$729,871	$1,543,149
2021	$3,660,569	$1,342,089	$2,318,480	$840,614	$2,819,954	$0	$2,819,954	26.4%	$744,468	$1,574,012
2022	$3,733,780	$1,368,931	$2,364,849	$857,427	$2,876,353	$0	$2,876,353	26.4%	$759,357	$1,605,492
2023	$3,808,456	$1,396,309	$2,412,146	$874,575	$2,933,880	$0	$2,933,880	26.4%	$774,544	$1,637,602
2024	$3,884,625	$1,424,236	$2,460,389	$892,067	$2,992,558	$0	$2,992,558	26.4%	$790,035	$1,670,354
2025	$3,962,317	$1,452,720	$2,509,597	$909,908	$3,052,409	$0	$3,052,409	26.4%	$805,836	$1,703,761
2026	$4,041,563	$1,481,775	$2,559,789	$928,106	$3,113,457	$0	$3,113,457	26.4%	$821,953	$1,737,836
2027	$4,122,395	$1,511,410	$2,610,985	$946,668	$3,175,727	$0	$3,175,727	26.4%	$838,392	$1,772,593
2028	$4,204,843	$1,541,638	$2,663,204	$965,602	$3,239,241	$0	$3,239,241	26.4%	$855,160	$1,808,045
2029	$4,288,939	$1,572,471	$2,716,468	$984,914	$3,304,026	$0	$3,304,026	26.4%	$872,263	$1,844,206
2030	$4,374,718	$1,603,921	$2,770,798	$1,004,612	$3,370,106	$0	$3,370,106	26.4%	$889,708	$1,881,090
Nominal IRR										
1986-2012:			12.2%							8.1%
1986-2018:			14.5%							11.2%
1986-2024:			15.3%							12.3%
1986-2030:			15.6%							12.7%

Notes and Sources:

[1] - [2], [4]: Source for 1986-2012: Rogers Communications annual financial data. An annual inflation rate of 2% is applied 2013 onwards.
1986 and 1987 depreciation and amortization expense is approximated assuming capital expenditures were depreciated over 10 years, straight line, with mid-year convention.

[3]: [1] - [2].

[5]: [1] - [4].

[6]: Negative EBIT amounts in [5] carried forward up to 7 years to offset positive EBIT in [5]. Source for NOL expiration years: Canada Revenue Agency. Tax loss carryforwards for 2005 & 2006 were acquired from Microcell (source: 2004 Annual Report for Rogers Communications, Inc., page 97.)

[7]: Maximum of 0 and ([5] - [6]).

[8]: Annual Reports for Rogers Communications, Inc.

[9]: [7] x [8].

[10]: [3] - [9].

2. Rogers Wireless Projected Cash Flows

As with TELUS, for the purpose of calculating IRRs we assume that Rogers' 2012 wireless performance remains constant in real terms through 2018, 2024, and 2030. To the extent that Rogers' 2012 performance understates its future wireless cash flows, Rogers' wireless IRRs are even higher than those presented above. If expenditures were made in 2012 to grow, rather than maintain, its business, then one might expect that Rogers' future cash flows arising from its pre-existing investments would outperform the projections used in our analysis.[121]

For example, as shown in Table A-6, Rogers' wireless FCFs during the first three quarters of 2013 were 12.2% larger than its FCFs during the first three quarters of 2012.[122] Based on this trend, real FCF growth from 2012 to 2013 will actually be positive and our assumption of zero real growth from 2012 is conservative.

Table A-6. Growth in Rogers Wireless FCF from 2012 to 2013 ($ M)
First 3 Quarters

	2013			2012			Percentage Changes from 2012 to 2013		
	Operating Profit	Capex	Free Cash Flow	Operating Profit	Capex	Free Cash Flow	Operating Profit	Capex	Free Cash Flow
Q1	$765	$239	$526	$737	$223	$514	3.8%	7.2%	2 3%
Q2	$821	$191	$630	$796	$215	$581	3.1%	-11.2%	8.4%
Q3	$875	$192	$683	$843	$299	$544	3.8%	-35.8%	25.6%
Total	$2,461	$622	$1,839	$2,376	$737	$1,639	**3.6%**	**-15.6%**	**12.2%**

Source: Rogers Communications, Inc. "Supplemental Financial Information," Q1, Q2, and Q3 2013.

3. Rogers Wireless WACC Calculation

The appropriate competitive benchmark for Rogers wireless IRR is the after-tax WACC. To develop this benchmark, we start with the Rogers WACC published by Bloomberg, L.P. As shown in Table A-7, Rogers' WACC as of the middle of each year (*i.e.*, June 30th) ranged from 6.2% (2011) to 9.9% (2008) since 2000. WACC estimates are available from Bloomberg only from 2000 onwards.

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[121] As shown in Table A-5, Rogers' wireless annual capital investments exceeded its depreciation and amortization expense by about 60% for 2010 thru 2012. To the extent that accounting measures of depreciation and amortization represent true "economic" depreciation and amortization of the assets involved, this excess suggests that Rogers Wireless' capital spending was above the amount needed to maintain the real value of its property plant and equipment PP&E. When a firm's capital spending exceeds this maintenance level, this excess should be expected to generate real future growth in future cash flows.

[122] As shown in Table A-6, some of this percentage FCF increase was the result of lower year-over-year capital spending (Capex) during the 2nd and 3rd quarters of 2013.

In principle, however, the competitive benchmark for Rogers' wireless IRR should reflect the opportunity costs of capital for Rogers' wireless business since 1986. To fill this time gap in Bloomberg's WACC data, we back cast Bloomberg's WACC estimates to 1986 by adding: (a) Canada's annual, nominal risk-free rates during 1986-1999, and (b) the average difference between Rogers' nominal WACC and Canada's nominal risk-free rates during 2001-2012 (+3.77 percentage points).[123] This calculation is shown in Table A-8. The Rogers' nominal WACCs between 1986 and 1999 using this approach ranged from 9.1% (1998) to 14.4% (1990).

As discussed above for TELUS, Rogers' WACC varied over time and needs to be collapsed into a single number to compare to Rogers IRR. To construct a comparable competitive benchmark for that IRR, we calculate weighted averages of Rogers' annual WACCs, using Rogers Wireless' real annual investment dollars as weights. As shown in Table A-7, this procedure yields a "blended" WACC for Rogers of 8.1% through 2030.

Similar to our analysis of TELUS, we use the WACC for Rogers, rather than just its wireless business. Unlike TELUS, however, it is calculated on an after-tax basis and is not biased upwards by tax payment adjustments. Nevertheless, we believe the consolidated WACC is reasonable to use for Rogers' wireless business investments.[124] Although Rogers' WACC has decreased over time, its decline is much less than for TELUS and we believe any potential downward bias from how we averaged the WACCs would not be sufficient to reverse our qualitative conclusions.

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[123] This premium for 2000 was lower (1.53 percentage points). To implement this calculation, we use the 10-year Canada benchmark bond yields reported by the Bank of Canada as of June for each year, obtained from: http://www.bankofcanada.ca/rates/interest-rates/selected-historical-interest-rates/.

[124] Rogers' business units primarily are made up of wireless and cable segments. In separate analyses, we compared Rogers' WACC to Shaw (a Canadian cable company), Microcell (a Canadian wireless company), analyst benchmarks and Rogers Wireless' WACC when it was publically traded and concluded Rogers' firm-wide WACC was a reasonable approximation of the WACC for its wireless business.

Table A-7. Blended Average WACC for Rogers

Year	Rogers Wireless Nominal Capex and Other Cash Investments (CAD '000)	Deflator (1986 = 1.000)	Rogers Wireless Real Capex and Other Cash Investments (CAD '000)	Estimated Rogers Ex-Ante Nominal After-Tax WACC
	[1]	[2]	[3]	[4]
1986	$62,814	1.025	$61,291	12.7%
1987	$52,651	1.071	$49,141	13.1%
1988	$91,646	1.113	$82,315	13.5%
1989	$261,328	1.172	$222,908	13.2%
1990	$495,568	1.241	$399,431	14.4%
1991	$162,456	1.287	$126,202	13.9%
1992	$240,731	1.315	$183,036	11.9%
1993	$181,400	1.337	$135,681	11.1%
1994	$182,403	1.340	$136,115	12.9%
1995	$185,600	1.363	$136,135	11.6%
1996	$553,800	1.393	$397,599	11.5%
1997	$604,700	1.404	$430,781	9.9%
1998	$301,300	1.418	$212,526	9.1%
1999	$420,250	1.455	$288,845	9.2%
2000	$526,000	1.502	$350,304	7.4%
2001	$1,051,300	1.512	$695,111	7.7%
2002	$564,600	1.570	$359,646	7.3%
2003	$411,900	1.602	$257,039	7.4%
2004	$1,946,900	1.637	$1,189,567	7.4%
2005	$585,000	1.671	$350,130	7.3%
2006	$684,000	1.699	$402,647	7.1%
2007	$822,000	1.739	$472,650	9.3%
2008	$1,937,000	1.759	$1,100,996	9.9%
2009	$905,000	1.783	$507,683	9.3%
2010	$1,010,000	1.825	$553,566	8.4%
2011	$1,192,000	1.866	$638,642	6.2%
2012	$1,123,000	1.882	$596,710	6.4%
2013 - 2030	$24,526,947		$10,740,771	7.2%
Percentage of 1986-2012 Total				
1986-1999:	22.9%		27.7%	
2000-2012:	77.1%		72.3%	
Blended Average WACC				
1986-2012:				9.0%
1986-2018:				8.5%
1986-2024:				8.2%
1986-2030:				8.1%

Notes and Sources:

[1]: See Appendix Table A-5.

[2]: Church and Wilkins 2013, Table 4.

[3]: [1] / [2].
2013 - 2030 assumes [2] reflects 2% annual inflation.

[4]: See Appendix Table A-8.
WACC for 2013 - 2030 assumed to equal average real WACC for 2010-2012 (5.1%) adjusted for 2% inflation.
Blended Average WACC calculated as a weighted average of [4], using the real investment in [3] as weights.

Table A-8. Estimated Annual WACC for Rogers: 1986-2012

Year	WACC (%)	Risk Free Rate (%)	WACC difference from Risk Free Rate (%)
	[1]	[2]	[3]
1986	12.7	8.9	
1987	13.1	9.3	
1988	13.5	9.7	
1989	13.2	9.4	
1990	14.4	10.6	
1991	13.9	10.1	
1992	11.9	8.2	
1993	11.1	7.3	
1994	12.9	9.1	
1995	11.6	7.8	
1996	11.5	7.8	
1997	9.9	6.1	
1998	9.1	5.4	
1999	9.2	5.5	
2000	7.4	5.9	1.5
2001	7.7	5.9	1.8
2002	7.3	5.4	1.8
2003	7.4	4.5	3.0
2004	7.4	4.8	2.6
2005	7.3	3.8	3.6
2006	7.1	4.6	2.5
2007	9.3	4.6	4.8
2008	9.9	3.7	6.1
2009	9.3	3.4	5.9
2010	8.4	3.1	5.3
2011	6.2	3.1	3.1
2012	6.4	1.7	4.7
Simple Average			
2001-2012:			3.8

Notes and Sources:

Table reflects mid-year values, reported at the end of Q2.

Source for 2000-2012: Bloomberg, L.P.

[1]: In 1986 - 1999, equal to [2] + 2001-2012 average of column [3].

[2]: Source for 1986-1999: Government of Canada 10 Year Benchmark Bond Yield. See http://www.bankofcanada.ca/wp-content/uploads/2010/09/selected_historical_page13.pdf.

[3]: [1] - [2].

Appendix B. Calibration of the Logit Model

As explained in the report, we model the effects on consumer prices, consumer surplus, and total surplus using an underlying consumer demand model for wireless telecommunication services based on a logit assumption. To make predictions as to equilibrium prices and market shares, we combine this logit demand specification with an assumption of Nash-Bertrand competition, where each firm, in equilibrium, is choosing a price that maximizes its own profits accounting for the price behavior of its rivals.

In the subsections below, we describe the specific details of the logit demand model, the data and assumptions that we employ in order to calibrate the logit model, and the details of the calibration methodology.

A. Model details

1. Consumer Demand

The logit model builds off of an assumption of utility maximization by consumers who are choosing among a set of discrete product alternatives. We define a product to be the collection of wireless services chosen by the average consumer of each of the wireless telecommunications providers, where we distinguish consumers across provinces.[125]

For example, Alberta is assumed to be a separate geographic market, and within this market, Rogers, Bell, and TELUS are each selling wireless subscriptions.[126] Each consumer, therefore, chooses whether to buy a wireless subscription from Rogers versus one from Bell or TELUS. The utility that consumer i would gain from consuming product j is assumed to take the form:[127]

$$U_{ij} = \delta_j - \alpha p_j + \epsilon_{ij}$$

In this specification, δ_j denotes the deterministic, product-specific utility that each consumer would gain from product j, which is assumed here to be constant across all consumers. Prices are denoted by p_j, which are also assumed to be constant across all consumers. Consumers earn lower net utility as a result of higher prices, and therefore α is assumed to be positive.

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[125] Due to data limitations, we make no distinction between postpaid or prepaid plans. We also make no distinction between the various baskets of services that individual consumers might actually have available to them to buy from each of the wireless carriers. See the data description for more details.

[126] As noted above, for purposes of this report, we did not perform a formal product or geographic market analysis of mobile telephony services. This assumption is not intended to convey a formal definition of the telecommunications market(s) in Canada.

[127] We follow the model of Werden and Froeb 1994. Our model differs primarily in notation only, although specific details on calibration are described below. See also Berry 1994.

Consumer-specific variation in utility comes only from the "idiosyncratic" portion of utility, ϵ_{ij}, which is assumed to follow an extreme value distribution.

Finally, the model allows for consumers to opt not to choose any product from the set, electing instead to "purchase" the outside good, product *0*. These assumptions lead to the familiar logit form of demand that expresses the probability a consumer will choose product j (which in expectation is also equal to its market share), after accounting for the presence of the outside good, as:

$$s_j = \frac{exp(\delta_j - \alpha p_j)}{\sum_{k=0}^{J} exp(\delta_k - \alpha p_k)}.$$

Using information on prices, observed "inside" shares (*i.e.*, the share of subscribers for each carrier in each province), price-cost margins, and the market elasticity of demand, the model "primitives" δ_j and α can be inferred, or *calibrated*. We use knowledge of the model primitives to make inferences about the equilibrium prices, shares, and market penetration in each province associated with the entry of a new carrier into the wireless market.[128] The remainder of this section explains the details of the data, assumptions, and calibration methodology.

2. Firm Pricing Behavior

Firms are assumed to maximize profits. With market size (*i.e.*, potential number of customers) denoted by M, firm profits are

$$\pi_j = (p_j - c_j) M s_j(p) - F_j,$$

where $s_j(p)$ indicates that the share of product j depends on the prices across all J products, and F_j denotes firm-specific fixed-costs. Profit maximization implies that the following first-order condition holds:

$$1 + \alpha(p_j - c_j)(s_j - 1) = 0$$

such that optimal margins, and therefore prices, satisfy the equation:

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[128] Note that most of the literature covering logit demand models centers on questions of product acquisition and mergers, or on questions of policy such as taxation or import quotas. The limited literature covering entry typically addresses the *ex-post* measurement of entry (*e.g.*, Nevo 2000) or relies on stated preference surveys which elicit choices from consumers based on a hypothesized set of choices that include the new product (*e.g.*, David Brownstone and Kenneth Train, "Forecasting New Product Penetration with Flexible Substitution Patterns," *Journal of Econometrics*, Vol. 89 (1999): 109-129). As explained in further detail below, we consider a range of scenarios and information that allow us to infer the model primitives for a new wireless carrier, in spite of lacking any specific information on new entrant shares or prices.

$$m_j = \frac{(p_j - c_j)}{p_j} = \frac{1}{\alpha p_j \left(1 - s_j(p)\right)}.$$

B. Data and Assumptions

1. Data

We observe limited information on shares, prices, and margins. Regarding shares, the primary limitation is that we only observe shares of all wireless subscriptions and not basket-specific shares (*e.g.*, we cannot distinguish between postpaid data plans exceeding 2GB/month allowance and postpaid with no data allowance or <500MB/month allowance).

However, we do observe subscriber shares by province for each carrier, as reported by the CRTC.[129] These subscriber shares are used to determine inside-good shares within the context of the logit model. Market size M^p in province p, used for calculation of variable profits, consumer, and total welfare, is implied by dividing the number of known province-level subscribers by the provincial inside-good share, $1 - s_0^p$.[130]

We proxy prices based on ARPU.[131] This information is observed by province across all carriers, and by carrier across all provinces. As it is generally the case that most subscription plans are nationwide plans,[132] we assume that the primary difference in province-level ARPU is a result of differences in consumer preferences for different plan selection (*e.g.*, 2GB versus 500MB data plans) across provinces.[133]

Building on this assumption, we infer carrier-specific ARPU for each province such that the share-weighted average ARPU across carriers equals the observed province-level ARPU, and that the ratio of pricing at the nationwide level across carriers also holds at the province level.[134]

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129 CRTC 2013.

130 Province-level number of subscriptions estimated from population statistics from Statistics Canada, available at http://www.statcan.gc.ca/start-debut-eng.html, and provincial mobile penetration and coverage data from CRTC 2013, Table 5.5.10, and Canadian Radio-television and Telecommunications Commission, "Communications Monitoring Report," September 2012 (hereinafter "CRTC 2012"), Table 5.5.11.

131 Barclays 2013, Figure 80.

132 Wall 2013, Table A2.2.

133 Wall 2013, Table A2.4, and CRTC 2012.

134 Let s_j^{cp} denote carrier j's share in province p, p_j^{cp} denote carrier j's price in province p, p_j^c denote carrier j's nationwide-level price, and $\bar{p}^p$ denote the average province-level price across all carriers.

Continued on next page

We observe margins and incremental (marginal) costs only at the carrier level, calculated from financial reports and levelized to account for the up-front costs associated with customer acquisition. We assume, for lack of better information, that these marginal costs remain constant across provinces for each carrier as well.

The carrier-level marginal costs and margins are reported in Table B-1 below. Given the assumed invariance of marginal costs across provinces, we derive implied province-level margins for each carrier using the inferred carrier-province ARPU values described above. The margins are calculated as variable profit (ARPU minus cost) divided by ARPU.

Continued from previous page

Then $\sum_j s_j^{cp} p_j^{cp} = \bar{p}^p$ and $p_j^{cp}/p_k^{cp} = p_j^c/p_k^c$ for all *j*,*k*. This setup results in *J* linear equations and *J* unknown prices p_j^{cp}, which are then solved for using Gaussian elimination.

Table B-1: Implied Effect of Verizon Entry on Variable Profits

		Units	Rogers	Bell	TELUS
[1]	Percent Change in Stock Market Value from Event Study		10.4%	5.2%	10.9%
[2]	Probability of Verizon Entry		0.5	0.5	0.5
[3]	Wireless as a % of Total Equity Value		71.5%	43.2%	89.8%
[4]	Implied Change in Wireless Equity Value		29.0%	24.0%	24.3%
	Monthly Equivalent Financial Data for Wireless Segment				
[5]	Network Revenue	$/sub/month	59.65	56.05	59.59
[6]	- Variable Cost	$/sub/month	-32.19	-32.39	-31.91
[7]	= Variable Profit	$/sub/month	27.46	23.66	27.68
[8]	- Fixed Costs	$/sub/month	-15.06	-11.96	-13.17
[9]	= EBIT	$/sub/month	12.41	11.70	14.51
[10]	**Variable Margin**		**46.04%**	**42.22%**	**46.45%**
[11]	Market Value Debt	$ millions	10,912	15,621	6,887
[12]	+ Market Value Equity	$ millions	19,018	32,487	10,694
[13]	= Market Value Asset	$ millions	29,930	48,108	17,581
[14]	PV(Equity)/PV(Asset)		63.5%	67.5%	60.8%
[15]	PV(Var Profit)/PV(Asset)		221.4%	202.3%	190.7%
[16]	**Implied Percentage Change in Variable Profit**		**8.329%**	**7.997%**	**7.756%**

Notes:

[1]: Table 7, sum of events 5 and 6.
[2]: Assumption.
[3]: Wireless EBIT as a % of consolidated EBIT, calculated from company annual reports.
[4]: [1] / [2] / [3].
[5]-[9]: Calculated present value based on segment financials in company annual reports.
[10]: [7] / [5].
[11]-[12]: Data from Bloomberg.
[13]: [11] + [12].
[14]: [12] / [13].
[15]: [7] / [9].
[16]: [4] x [14] / [15].

We also calculate the percentage changes in each carrier's variable profits from wireless operations that results from Verizon Wireless' proposed market entry.[135] The logit model is ill-suited for producing estimates of total firm profits, since it does not rely on estimates of fixed costs (*e.g.*, fixed administrative, sales, or marketing costs) associated with a firm's continuing operation. However, it can be used to provide estimates of variable profits for each carrier. Based on information on wireless operating income and EBIT for each carrier, we translate the

[135] See Section IV, Subsection A of the main report.

estimated impact of Verizon's entry on prices and shares into estimates of the expected percentage change in each carrier's variable profits.[136]

2. Assumptions

We employ three main parameter assumptions to assist with model calibration. The first is the market elasticity. We assume that the variation in ARPU across provinces is largely driven by consumer preferences, and capture this by assuming that lower ARPU provinces exhibit greater elasticity than higher ARPU markets. Table B-2 assumes a linear relationship between province-level ARPU and associated market elasticity, where $\varepsilon^p = -2.205 + 0.023\bar{p}^p$,[137] resulting in the reported elasticities. We conducted sensitivity analysis around the market elasticity assumptions, and found that the qualitative results of this report are not sensitive to small changes in the elasticity.

Table B-2: Province Average Revenue per User and Market Elasticity

Province	ARPU	Elasticity
Alberta	73.50	-0.50
British Columbia	63.56	-0.73
Manitoba	59.31	-0.83
New Brunswick	55.32	-0.92
Newfoundland and Labrador	59.69	-0.82
Nova Scotia	58.94	-0.84
Ontario	61.87	-0.77
Prince Edward Island	53.08	-0.97
Quebec	51.95	-1.00
Saskatchewan	63.30	-0.74

In addition to the market elasticities, we must also assume values for the parameters of the outside good: p_0 and δ_0. The logit model parameters are only identified in relation to the outside good parameters, and as a consequence, the choices for these values are arbitrary. Many practitioners assume $p_0 = 0$, and we follow their lead here.[138] We also set $\delta_0 = 0$.[139]

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136 Wireless segment EBIT and EBITDA information is based on each firm's 2012 financial reports.

137 The parameters of the relationship derive from assuming linearity and that the elasticity varies from a value of -0.5 for the highest-ARPU province (Alberta) to -1.0 for the lowest-ARPU province (Quebec). Note that we exclude the three northern territories, which have fewer than 10,000 subscribers combined (see CRTC 2013, Table 5.5.7).

138 Werden and Froeb 1994 sets $p_0 = 0$ and δ_0 equal to an arbitrary high value. Berry 1994 sets $\delta_0 - \alpha p_0 = 0$, which would be satisfied at $\delta_0 = p_0 = 0$.

C. Parameter Calibration Methodology

For each province and each elasticity scenario, we calibrate the logit demand model described above to determine the market-level parameters α and s_0, as well as the firm-specific parameters for the incumbents: δ_j and marginal costs c_j. Existing share, price, and margin information cannot inform the parameters of the new entrant. We discuss the methodology used to infer δ_E and c_E in detail below.

1. Pre-Entry Conditions

The logit share equation can be written to be linear in its parameters, such that:

$$\log(s_j) - \log(s_0) = \delta_j - \alpha p_j.^{140}$$

Conditional on knowing α and s_0, this results in J linear equations that perfectly identify the unknown values for each of the δ_j parameters. We do not directly observe the share for the outside good, but its value can be calibrated as an unknown parameter along with α. Conditional on α and the assumed market elasticity, the outside share is expressed as $s_0^p = -\varepsilon^p / \alpha \bar{p}^p$, where ε^p denotes the province-level market elasticity and $\bar{p}^p$ is the province-level average inside-good price.[141]

Additionally, the first-order conditions described above provide further identification via the markup information. Although technically only one first-order condition (or markup equation) is needed to secure identification, we incorporate the first-order conditions for all three of the major incumbents (Rogers, Bell, and TELUS). This results in three equations and an over-identified system. We then solve for α (and thus s_0) by minimizing the sum of squares across all

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Continued from previous page

139 Calculation of the change in consumer surplus is improved by setting δ_0 at a "high" value, but note that $exp(\delta_j - \alpha p_j)$ increases rapidly in δ_j (which tends to increase with δ_0), such that computation issues arise even for $\delta_j - \alpha p_j > 700$. See Werden and Froeb 1994, footnote 9.

140 See Berry 1994, Equation 14. Note that we have eliminated p_0 and δ_0 in this equation as both are equal to 0.

141 See Werden and Froeb 1994, p. 411.

three (nonlinear) equations.[142] Given the calibrated values for α, s_0, and δ_j, values for c_j are inferred from the markup equations.[143]

2. Entrant parameters

Variable profits in the logit model are denoted:

$$V_j = (p_j - c_j)Ms_j(p).$$

We exploit the information from Verizon Wireless' statements regarding potential entry and their decision not to enter the Canadian wireless industry to infer the percentage change in variable profits that would result from successful entry.[144]

Let E denote the market value of the equity outstanding for the firm and D the market value of the firm's debt. The current market value of the firm is equal to $A = E + D$. Further let V denote the present discounted value of the stream of variable profits expected to be earned by the firm, and F the present discounted value of the firm's fixed costs. The current market value of the firm is then also equal to $A = V - F$. Hence, $E + D = V - F$.

If market equity E changes by an amount e (*e.g.*, 0.1, or 10%), then the value of the firm increases by an amount a (assuming no change in the market value of debt outstanding), such that $E(1 + e) + D = A(1 + a)$. Solving for a, we get $a = eE/A$. Given the increase in the expected current value of the firm, we can infer the expected change in the present discounted value of the firm's variable profits v, assuming no change in fixed costs. Since $A(1 + a) = V(1 + v) - F$, $v = aA/V$. Substituting for a, we have an expression for the expected change in variable profits as a function of the change in market equity:

$$v = e\frac{E}{A}/\frac{V}{A}.$$

This implies that the expected change in variable profits following a market event with associated change in equity value e is equal to the equity to asset ratio divided by the variable

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[142] We rely on the quasi-Newton method of Broyden, Fletcher, Goldfarb, and Shanno (BFGS) to minimize the sum of squares of our identifying equations. See Kenneth Judd, *Numerical Methods in Economics*, The MIT Press (1998), pp. 114-115. We also restrict α such that $\alpha > -\varepsilon^p/\bar{p}^p$. See Werden and Froeb 1994.

[143] We are interested in comparing pre-entry to post-entry outcomes, and therefore calibrate marginal costs in each province based on the markup equations. These marginal costs differ province-by-province across carriers, and differ from the "observed" marginal costs described above. Following this procedure maintains any calibration error in both the pre-entry and post-entry predictions.

[144] We consider a range of probabilities for Verizon's successful entry associated with the observed stock market price effects, from 0.5 to 1.0.

profit (levelized operating income) to EBIT ratio. Row 4 of Table B-1 shows the expected change in equity for the wireless divisions of the three nationwide incumbent carriers following Verizon's announcements regarding its entry decision in Canadian wireless services. Because we calculate equity and variable profits in different units, we calculate E/A in Row 14 based on the market value of equity and debt outstanding in Bloomberg, and V/A in Row 15 based on information in the companies' financial reports and our own calculation of the variable margins. Row 16 of Table B-1 provides the implied percentage change in variable profits following Verizon's entry announcements, and is approximately 8% for each of the three nationwide incumbent carriers.[145]

Starting from the logit model's predictions of variable profits, we infer values for the new level of variable profits for each of the three main incumbent firms based on the event study's implied percentage change in variable profits. The resulting target values for variable profits are summarized in Table B-3. We combine this information into the profit equations for the three incumbent firms. The resulting equations are minimized over their sum of squared values to calibrate a value for δ_E that is consistent with the event study predictions.[146] We then use the share equations and first-order conditions across the new set of firms to predict changes in shares, prices, industry revenues, and consumer surplus.

[145] These numbers are dependent on the assumption of the financial market's assessment of Verizon's probability of entry. The expected change in variable profits falls to approximately 4% if the market assessment of Verizon's probability of entry was instead 1.0.

[146] We assume that the marginal cost for the entrant, c_E, is equal to the average marginal cost inferred from the model across the incumbent wireless carriers. Other plausible assumptions, such as using the maximum inferred marginal cost across the incumbent carriers, have no material impact on our results.

Table B-3: Variable Profit Target for Logit Model Calibration

Province	Pre-Entry Variable Profit		Post-Entry (Event Prob .5) Variable Profit			Post-Entry (Event Prob 1) Variable Profit		
	Big 3 [1]	Other [2]	Big 3 [3]	Other [4]	Entrant [5]	Big 3 [6]	Other [7]	Entrant [8]
Alberta	2,033.16	44.64	1,868.28	40.44	134.40	1,950.72	42.48	64.68
British Columbia	1,389.24	32.40	1,276.68	29.52	108.84	1,332.84	30.96	52.20
Manitoba	144.48	208.80	132.36	193.32	27.12	138.48	201.12	13.08
New Brunswick	184.92	0.00	169.56	0.00	15.36	177.12	0.00	7.44
Newfoundland and Labrador	208.08	0.00	190.68	0.00	15.60	199.44	0.00	7.56
Nova Scotia	272.64	0.00	250.32	0.00	22.08	261.48	0.00	10.56
Ontario	3,893.52	232.32	3,569.76	211.56	361.32	3,731.52	221.88	173.16
Prince Edward Island	33.00	0.00	30.24	0.00	2.76	31.68	0.00	1.32
Quebec	1,263.24	120.12	1,161.84	110.16	131.64	1,212.48	115.08	63.12
Saskatchewan	88.20	388.92	81.00	366.72	24.48	84.72	378.00	11.76
Canada	9,510.48	1,027.20	8,730.72	951.72	843.60	9,120.48	989.52	404.88

Notes:
[1]: Pre-entry sum of variable profits for all Rogers, Bell Group, and TELUS.
[2]: Pre-entry sum of variable profits for other incumbent carriers.
[3]-[8]: Post-entry sum of variable profits.

D. Penetration and Consumer Surplus Effects of Entry

We predict province-level penetration by first predicting the number of subscribers, $(1 - s_0^p)M^p$. Penetration is then then number of subscribers in a province divided by the province's population.

We predict the change in consumer surplus via the formula:

$$\frac{\left[\log \sum_j exp\left(\delta_j - \alpha p_j^1\right) - \log \sum_j exp\left(\delta_j - \alpha p_j^0\right)\right]}{\alpha},$$

where p_j^0 denotes pre-entry prices and p_j^1 denotes post-entry prices.[147] This formula only captures the change in consumer surplus. Consequently, in order to place the value in perspective, we compare it to the level of industry revenues that are predicted within the model.

E. Detailed Share and Price Effects Across Event Study Scenarios

For expositional purposes, we include in this subsection more detailed tables on the effect of entry on shares and prices across the two event study scenarios.

[147] Adapted from Werden and Froeb 1994, Equation 9.

Table B-4: Entrant and Incumbent Shares by Event Study Scenario

Province	Pre-Entry Market Share		Post-Entry (Event Prob .5) Market Share			Post-Entry (Event Prob 1) Market Share		
	Big 3 [1]	Other [2]	Big 3 [3]	Other [4]	Entrant [5]	Big 3 [6]	Other [7]	Entrant [8]
Alberta	97%	3%	89%	3%	8%	93%	3%	4%
British Columbia	97%	3%	88%	3%	9%	92%	3%	5%
Manitoba	47%	53%	42%	48%	10%	44%	51%	5%
New Brunswick	100%	0%	89%	0%	11%	95%	0%	5%
Newfoundland and Labrador	100%	0%	89%	0%	11%	94%	0%	6%
Nova Scotia	100%	0%	90%	0%	10%	95%	0%	5%
Ontario	93%	7%	84%	6%	10%	88%	7%	5%
Prince Edward Island	100%	0%	90%	0%	10%	95%	0%	5%
Quebec	90%	10%	81%	9%	10%	85%	9%	5%
Saskatchewan	29%	71%	26%	66%	8%	27%	69%	4%
Canada	90%	10%	82%	9%	10%	86%	9%	5%

Notes:

[1]: Pre-entry percent of total subscribers for Rogers, Bell Group, and TELUS.

[2]: Pre-entry percent of total subscribers for other incumbent carriers.

[3]-[8]: Post-entry percent of total subscribers.

Table B-5: Entrant and Incumbent Prices by Event Study Scenario

Province	Pre-Entry	Post-Entry (Event Prob .5)			Post-Entry (Event Prob 1)		
	Average Incumbent Price [1]	Average Incumbent Price [2]	Entrant Price [3]	Average Price [4]	Average Incumbent Price [5]	Entrant Price [6]	Average Price [7]
Alberta	73.50	72.46	64.48	71.79	72.98	63.30	72.57
British Columbia	63.56	62.92	57.75	62.44	63.24	56.82	62.94
Manitoba	59.31	58.62	56.42	58.40	58.96	55.55	58.80
New Brunswick	55.32	54.59	51.37	54.25	54.95	50.54	54.72
Newfoundland and Labrador	59.69	58.20	53.86	57.72	58.95	52.77	58.60
Nova Scotia	58.94	58.17	54.23	57.77	58.55	53.32	58.28
Ontario	61.87	61.29	57.82	60.93	61.58	56.81	61.33
Prince Edward Island	53.08	52.41	49.50	52.10	52.75	48.75	52.53
Quebec	51.95	51.64	50.64	51.54	51.80	49.93	51.70
Saskatchewan	63.30	62.22	61 27	62.15	62.77	60.43	62.68
Canada	61.47	60.80	57.06	60.44	61.13	56.13	60.89

Notes:

[1], [2], [5]: Share-weighted average price of all incumbent carriers.

[3], [6]: Price charged by new entrant.

[4], [7]: Share-weighted average price of all carriers.

Appendix C. Network Modeling

The nature of wireless network engineering and scarcity of wireless spectrum results in a trade-off between the number of carriers and the costs of providing wireless services. Building wireless service capacity requires a combination of both capital and spectrum, but the proportion of each is not fixed. Rather, there typically is a trade-off between the amount of spectrum and the capital investment in cell sites and other equipment required for some volume of wireless voice and data. Spectrum and network equipment are essentially substitutes for one another.

To accommodate a larger number of carriers, the market must allocate less spectrum to each carrier, thereby increasing the capital requirements of each carrier. This suggests that there exists a trade-off between the benefits of increased competition and the higher costs for individual carriers with less spectrum.

The potential consumer surplus from an additional strong nationwide carrier should be balanced against any additional capital investment required. Reserving this spectrum for a new or emerging nationwide carrier implies that incumbent carriers have less spectrum available with which to expand their network capacity.

To better understand the implications of this trade-off, we first model the LTE networks for each incumbent based on its total number of cell sites, available spectrum, and estimated coverage as of the end of 2012. The assumptions and parameters for this modeling are described in Section A below. Next, as described in Section B, we use this model to project where each carrier will need to expand network capacity and how many cells sites would be necessary to do so, depending on the availability of additional spectrum and network growth.

A. LTE Network Model

As a first step, we identify which census subdivisions we expect each carrier to cover and then estimate the number of cell sites covering each area. As described below, we estimate the proportion of the population covered by each carrier in each province based on data provided by the CRTC. We assume that the carriers attempt to minimize the number of coverage cell sites[148] required to cover a given portion of the population in each province. We then assume that the remaining cell sites in the province are available for a capacity build,[149] and we calibrate the model to determine the average capacity (in population per cell site) of a single capacity cell site

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[148] We consider a coverage cell site a site whose radius is determined by the maximum distance a transmission signal can travel, rather than the maximum population that can be served. By contrast, the radius of a capacity cell site is less than the radius of a coverage site, and is limited by the total population that can be served by a single cell site.

[149] The total number of capacity cell sites is equal to the total number of sites for each carrier, less the number of coverage sites estimated above.

in that province. Once we have calibrated the size of capacity cell sites by province and distribution of cell sites by carrier, we run experiments based on potential changes in the Canadian wireless telecommunications market.

1. Coverage

To identify which geographic areas each carrier covers within a province,[150] we use Canada 2011 Census data from Stats Canada for population and land area.[151] The census divides Canada into provinces, then divisions, and then subdivisions.[152] We assume that each carrier covers the most densely populated subdivisions within a province first.

We estimate the proportion of the population covered by LTE for each carrier and province as of the end of 2012 using data from the CRTC 2013 Monitoring Report. For each province, the CRTC publishes the percent of the population that is covered with some type of wireless broadband service by either four (or more), three, two, one, or zero wireless facilities.[153] The CRTC also publishes the wireless market share of all of the major carriers in each province, as well as overall wireless, LTE, and HSPA+ coverage rates by province.[154] We use this information to estimate LTE and HSPA+ coverage rates by carrier and province.

We assume that the carriers' market shares are generally consistent with their level of coverage. In other words the carrier with the highest market share is also the carrier that covers the greatest proportion of the population.[155] To estimate a carrier's LTE coverage rate in a given

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150 We model coverage by province because each carrier's network coverage varies substantially by province.

151 Statistics Canada. 2012. "Population and dwelling counts, for Canada and census subdivisions (municipalities), 2011 and 2006 censuses (table)." http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/hlt-fst/pd-pl/Table-Tableau.cfm?LANG=Eng&T=301&S=3&O=D

152 There are 293 populated divisions and the average division is 30,597 km^2 in size with a population of 114,254. There are 4931 populated subdivisions and the average subdivision is 1,707 km^2 in size with a population of 6,373.

153 See Table 5.5.11 in CRTC 2013.

154 See Table 5.5.5 and Table 5.5.10 in CRTC 2013. As explained below, we use the HSPA+ coverage as our target for continued LTE network expansion.

155 We make an exception to this rule in the far eastern and western provinces where we understand that TELUS and Bell generally share network facilities by roaming on each other's networks. (See, for instance, JP Morgan, September 20, 2013, p. 34.) In Newfoundland and Labrador, New Brunswick, Nova Scotia, and Prince Edward Island, where TELUS has higher subscriber share than Rogers, we still assume that Rogers has greater coverage than TELUS because TELUS is primarily roaming on Bell's network. Similarly, in Saskatchewan, where Bell has higher subscriber share than Rogers, we assume that Bell is primarily roaming on TELUS' network, so Rogers has greater coverage than Bell.

province, we scale down its overall wireless coverage rate by the ratio of LTE to all wireless coverage in that province.

Table C-1 shows the estimated LTE coverage rates for each carrier and province as of the end of 2012. For the purpose of predicting future cell site growth, we estimate target coverage for 2017. We assume that by 2017 each nationwide carrier builds its LTE network to cover the same population as its HSPA+ network serves as of 2012. To estimate 2012 HSPA+ coverage, we follow the same methodology as described above, but use the province level rates of HSPA+ coverage.

When our initial coverage estimate appears inconsistent with the number of cell sites for that province (see Table C-2), we conjecture that our coverage estimate is less accurate than the cell site estimate. In those cases, we use the estimated nationwide average cell site capacity (see Table C-4) to back out a new coverage percentage. For instance, in Prince Edward Island, we initially estimated Bell's coverage to be 0%, although we found that it has 11 LTE cell sites, suggesting that it has some coverage. Using the nationwide average capacity, we re-estimate that coverage to be 49%.

Table C-1. LTE Coverage By Province (2012, 2017 est.)

Province	Bell		Rogers		TELUS	
	2012 [1]	2017 [2]	2012 [3]	2017 [4]	2012 [5]	2017 [6]
Alberta	0%	0%	81%	99%	82%	100%
British Columbia	0%	0%	85%	97%	87%	99%
Manitoba	0%	0%	60%	96%	4%	6%
New Brunswick	16%	100%	15%	96%	0%	0%
Newfoundland and Labrador	30%	96%	7%	21%	0%	0%
Northwest Territory	37%	52%	0%	0%	0%	0%
Nova Scotia	37%	100%	36%	96%	0%	0%
Nunavut	0%	0%	0%	0%	0%	0%
Ontario	77%	99%	78%	100%	6%	8%
Prince Edward Island	49%	100%	24%	100%	0%	0%
Quebec	3%	4%	67%	95%	63%	89%
Saskatchewan	0%	0%	3%	8%	1%	2%
Yukon Territory	37%	52%	0%	0%	0%	0%

Source: Brattle Group Analysis of CRTC Communications Monitoring Report 2013
Alberta, British Columbia, Manitoba, and Saskatchewan are not modeled for Bell. Newfoundland and Labrador, the North, and the Maritime provinces are not modeled for Telus.
[1], [3], [5]: Estimated LTE coverage using three tables from the CRTC 2013 report: Table 5.5.5, Table 5.5.10, and Table 5.5.11.
[2], [4], [6]: Estimated HSPA+ coverage using the same tables. Carriers are assumed to build their LTE networks out to their current HSPA+ coverage levels.

Combining these coverage rates with the Census 2011 data, we estimate which census subdivisions are covered with LTE in 2012 and 2017 as well as which carriers we expect to cover each subdivision. We rank the subdivisions by population density[156] and assume that subdivisions are covered in order of density, with the densest subdivisions covered first and by the most carriers.

2. Cell Sites

Networks are constructed to achieve the dual goals of capacity and coverage. A "coverage build" focuses on using the minimum number of cell sites to extend signals over the largest possible land area. By contrast, a "capacity build" seeks to achieve a minimum threshold amount of capacity for every network user. A coverage build is suitable for sparsely-populated rural areas, whereas a capacity build is more appropriate for more populated urban and suburban areas.

All cell sites in a network are bounded in the amount of land area they can cover by the frequency of the spectrum used. We assume each carrier's LTE network is deployed on AWS spectrum and each cell site has a maximum effective distance of 5.4 km for AWS LTE cell sites.[157] This translates to a covered hexagonal area of 74.4 km^2.[158] We use this area to determine the number of cell sites required to cover a given amount of land area.

We also observe the number of cell sites each carrier operates in each province as of the end of 2012. Loxcel Geomatics provides maps with the locations of cell sites in a given network. We use images of these maps to count the estimated number of cell sites in each network by province. Table C-2 shows these estimates.

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156 Effective population density is calculated by multiplying the population density of the subdivision by the population density of the parent division. The interaction of these properties captures the granularity of subdivision-level population density while avoiding covering dense subdivisions within extremely sparse divisions that have been subdivided in an unbalanced way.

157 We use a table that relates frequency to several relative distances (Melone, Tony, "Wells Fargo Securities: Technology, Media & Telecom Conference," Verizon, November 10, 2010) and an estimate of 10 miles as the effective radius of a frequency of 700 MHz to estimate the parameters of an exponential function relating frequency to distance.

158 The area of a hexagon is equal to $\frac{3\sqrt{3}r^2}{2}$, where r is the maximum radius of the cell site.

Table C-2. Estimated Number of Cell Sites By Province (2012)

Province	Bell [1]	Rogers [2]	TELUS [3]
Alberta	0	424	418
British Columbia	0	520	517
Manitoba	0	69	7
New Brunswick	64	39	0
Newfoundland and Labrador	47	5	0
Northwest Territory	18	0	0
Nova Scotia	98	65	0
Nunavut	0	0	0
Ontario	1231	1664	160
Prince Edward Island	11	5	0
Quebec	55	696	517
Saskatchewan	0	39	2
Yukon Territory	5	0	0

Source: Brattle Group analysis of Loxcel Geomatics Cellular Map

3. Spectrum

We estimate the amount of spectrum available in each carrier's LTE network based on each carrier's weighted average AWS spectrum license holdings by province. Table C-3 shows weighted average AWS spectrum holdings for each carrier and province.

Table C-3. AWS Spectrum License Holdings (MHz) By Province (2012)

Province	Bell [1]	Rogers [2]	TELUS [3]
Alberta	10	20	30
British Columbia	10	20	30
Manitoba	0	20	20
New Brunswick	20	20	10
Newfoundland and Labrador	20	20	10
Northwest Territory	25	20	10
Nova Scotia	20	20	10
Nunavut	25	20	10
Ontario	20	20	15
Prince Edward Island	20	20	10
Quebec	10	20	20
Saskatchewan	0	20	20
Yukon Territory	25	20	10

Source: Brattle Group analysis of spectrum license data from Industry Canada
Province-level bandwidth estimated by aggregating MHz population for all licenses in a province, then dividing by the population of the province.
Calculated using population figures from the 2006 census.

4. Calibration

We assume that each network has an unobserved maximum capacity (population per cell site) for a given amount of spectrum. Our model calibrates to this estimated cell site capacity for each province and carrier by calculating the estimated number of capacity driven cell sites required to serve the province. We use our estimate of the total number of cell sites within the province for each carrier, and the number of cell sites required to cover the subdivisions identified, to estimate the additional capacity driven cell sites required. Once we estimate the number of coverage and capacity driven cell sites required, we can calibrate the maximum cell site capacity that fits these values.

We identify the covered subdivisions within a province as described above. The population and land area figures for covered subdivisions are then aggregated to the division level; that is, we note the total land area and total population covered within each division. We do this to reflect the observation that cell sites built in a subdivision might be able to provide service for nearby subdivisions (other subdivisions in the same division).

Next, within each division, we calculate the number of "coverage sites," which represent the cell sites required to serve the total *area* covered. At this point we can test a hypothesized maximum cell site capacity. We calculate both the number of possible "capacity sites," or cell sites required to serve the total *population* covered, and the number of possible coverage sites. The total cell sites required to serve a division is equal to the maximum of the capacity and coverage sites for

that division. The sum of the cell sites across all divisions within a province is the hypothesized total number of cell sites in that province. The maximum capacity per cell site is then the cell site capacity that yields the total cell sites that is equal to the observed cell sites in that province.

There are several cases in which the model cannot calibrate a maximum cell site capacity. In provinces where a carrier has no LTE coverage we do not calibrate such capacities. In other provinces, even where we do estimate LTE coverage, there may not be enough observed cell sites to reasonably calibrate the model to the level of coverage we draw from CRTC data. In all of those cases we expect that those uncalibrated provinces would use technology that is similar to those provinces that we were able to calibrate. Therefore, we apply a nationwide average capacity per cell site, adjusted for the province's bandwidth.[159] In those instances where the number of cell sites cannot calibrate based on the previously estimated coverage level, we re-estimate the LTE coverage based on the number of cell sites and nationwide average cell site capacity.

Table C-4 shows the calibrated capacity of each network in each calibrated province, as well as the number of coverage and capacity towers estimated during calibration.

[159] Nationwide maximum capacity per cell site is weighted by the number of sites in capacity-driven divisions, adjusted for the relative bandwidth.

Table C-4. Estimated Cell Site Capacity Calibration By Province

Carrier	Province	Cell Site Capacity (pops/MHz) [1]	Capacity @ Actual Band (pops) [2]	Initial Coverage Cells [3]	Initial Capacity Cells [4]
Bell	Alberta				
	British Columbia				
	Manitoba				
	New Brunswick	134	2,672	8	56
	Newfoundland and Labrador	195	3,910	8	39
	Northwest Territory	44	1,102	2	16
	Nova Scotia	-	-	-	-
	Nunavut	-	-	-	-
	Ontario	406	8,116	202	1,029
	Prince Edward Island				
	Quebec	-	-	-	-
	Saskatchewan				
	Yukon Territory	-	-	-	-
	Canada	381	7,622	-	-
Rogers	Alberta	357	7,134	153	271
	British Columbia	372	7,436	134	386
	Manitoba	568	11,353	14	55
	New Brunswick	223	4,465	8	31
	Newfoundland and Labrador	-	-	-	-
	Northwest Territory				
	Nova Scotia	-	-	-	-
	Nunavut				
	Ontario	302	6,046	210	1,454
	Prince Edward Island				
	Quebec	388	7,770	98	598
	Saskatchewan	266	5,324	3	36
	Yukon Territory				
	Canada	340	6,807	-	-
TELUS	Alberta	242	7,263	154	264
	British Columbia	258	7,733	141	376
	Manitoba	-	-	-	-
	New Brunswick				
	Newfoundland and Labrador				
	Northwest Territory				
	Nova Scotia				
	Nunavut				
	Ontario	-	-	-	-
	Prince Edward Island				
	Quebec	494	9,875	73	444
	Saskatchewan	-	-	-	-
	Yukon Territory				
	Canada	339	8,372	-	-

While blanks represent provinces in which there was no coverage and therefore no attempt to calibrate the model, dashes represent provinces in which there were too few observed cell sites to reasonably calibrate the model.

B. Network Expansion Experiments

In order to model the effects of a new entrant and additional spectrum, we test several hypothetical scenarios regarding the potential changes in each carrier's future LTE network, depending on whether there is an additional nationwide carrier. The emergence of an additional nationwide carrier could have at least two effects on incumbents' capacity needs. First, as discussed above in Section IV.B on the logit modeling, a new entrant is likely to take subscribers from the incumbents. Second, an additional carrier will require spectrum that could otherwise be used by the incumbent carriers. Below we model these two effects.

1. Network growth

We assume that LTE network capacity grows by roughly 25% annually between 2012 and 2017.[160] Moreover, this traffic growth is due to both coverage expansion into new areas and capacity expansion in already-serviced areas. In other words, we assume that each network grows both extensively and intensively. Specifically, for extensive growth, we assume that coverage expands linearly for five years until 2017 LTE coverage is similar to 2012 HSPA+ coverage. We model intensive growth by increasing the traffic in all covered areas by the remaining growth required to reach 25% total residual capacity growth.

2. Market Share of New Entrant

We assume that, if a new carrier were to emerge, it would take market share from the incumbents, and that the amount of share "stolen" from each incumbent is based on results from the logit model. Table C-5 shows the change in the market share for each incumbent.

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[160] Cisco projects that "[i]n Canada, 4G traffic will grow 15-fold from 2013 to 2018, a compound annual growth rate of 71%." See Cisco, Canada – Accelerating Network Speeds, VNI Mobile Forecast Highlights, 2013 – 2018, available at: http://www.cisco.com/assets/sol/sp/vni/forecast_highlights_mobile/index.html#~Country (last visited May 7, 2014). This was the first year Cisco projected 4G traffic growth in Canada, although we assume it is similar for 2012.

We assume that carriers built their LTE networks to accommodate at least some of this growth in demand, but networks still require some continued expansion. Supposing that LTE network capacity was roughly 20% utilized in 2012 and grows to be roughly 90% utilized by 2017, then the network capacity would have to expand by approximately 25% annually, assuming demand is growing approximately 70% annually.

Table C-5. Percent Change In Subscribers By Carrier Assuming Additional Nationwide Carrier

	Rogers [1]	Bell [2]	TELUS [3]
Alberta	-7.3%	-7.5%	-4.7%
British Columbia	-5.9%	-7.6%	-5.8%
Manitoba	-6.5%	-8.4%	-8.2%
New Brunswick	-8.2%	-4.9%	-8.0%
Newfoundland and Labrador	-10.4%	-4.3%	-8.9%
Nova Scotia	-8.2%	-5.0%	-7.2%
Ontario	-5.6%	-7.0%	-7.7%
Prince Edward Island	-8.5%	-4.9%	-7.6%
Quebec	-6.6%	-6.3%	-6.7%
Saskatchewan	-7.6%	-7.5%	-7.5%
Canada	-6.1%	-6.7%	-6.4%

Source: The Brattle Group Logit Model. See Appendix B.

3. Additional Spectrum

Network capacity can be increased in one of two ways. The first approach is through cell splitting and sectorization to reduce the size of cell radii and increase cell site density within the geographic area. This approach requires capital expenditures for additional cell sites. The second way to increase network capacity is to add spectrum to existing cell sites. An increase in the bandwidth of usable spectrum transmitted at a given tower results in a roughly proportional increase in the capacity of that tower. This implies that a 50% increase in operable spectrum results in a 50% increase in cell capacity.[161] Additional spectrum reduces the amount of cell splitting or sectorization needed to accommodate a particular capacity goal.

The availability of additional spectrum, however, would likely depend on whether there is a new entrant. As discussed in the report, at the time of the AWS spectrum auction in 2008, Industry Canada set aside 40 MHz of AWS spectrum for new entrants.[162] Similarly, Industry Canada

[161] We recognize that the spectral efficiency of LTE varies with channel size (up to at least 20 MHz) and other factors. (See Rysavy 2009, Figure 8.) The difference, however, is secondary to the linear impact of additional spectrum. Furthermore, for the purposes of this model we do not know specifically what channel size each carrier would use in each scenario and, therefore, ignore this issue.

[162] This 40 MHz was set aside in the AWS B, C and D blocks. Licenses set aside for a new entrant could not be transferred to a non-new entrant company for five years after the date of issuance, following the spectrum auction in 2008. See Industry Canada, "Policy Framework for the Auction for Spectrum Licenses for Advanced Wireless Services and other Spectrum in the 2 GHz Range," November 2007,

Continued on next page

reserved 10 or 12 MHz of prime 700 MHz for new entrants in that auction.[163] Whether spectrum originally set aside for new entrants is ultimately available for incumbent LTE expansion likely depends on a number of factors, including whether there is a strong new entrant and, if there is no new entrant, whether incumbent carriers are allowed to acquire this spectrum.[164]

If an additional nationwide carrier were to enter the wireless market, we assume that the spectrum set aside in both the AWS and 700 MHz auctions would likely remain in the hands of new entrants. In this case, each incumbent is likely to get at least an additional 10 MHz of paired spectrum, which we assume that carriers would be in a position to deploy in 2015.[165] If there is no new entrant, each carrier could receive an additional 10 or 20 MHz of AWS spectrum from the set aside bands. This spectrum would be available immediately. We estimate the effect of this spectrum being deployed in 2014.

Table C-6 summarizes the network expansion assumptions discussed above.

Continued from previous page

pp. 5-6, available at: http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf08833.html (last visited February 4, 2014).

163 For the 700 MHz auction, each of the large wireless service providers are limited to one paired spectrum block within the B (2 x 6 MHz), C (2 x 6 MHz), C1 (2 x 5 MHz) and C2 (2 x 5 MHz) blocks. These limits are in place for the first five years after license issuance. The large providers can also bid freely on the two unpaired 6 MHz D and E blocks and the paired 6 MHz A block. See Industry Canada, "Licensing Framework for Mobile Broadband Services (MBS) — 700 MHz Band," March 2013, Table 1 (band plan) and para. 243, available at http://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf10572.html (last visited February 4, 2014). This essentially limits two of the three nationwide incumbents to 10 MHz or 12 MHz of paired spectrum (with the third incumbent getting 22 MHz or 24 MHz of paired spectrum) and another 5 MHz to 10 MHz of unpaired spectrum, leaving at least 10 MHz or 12 MHz of paired spectrum for a new entrant.

164 Although the five year moratorium on selling set aside AWS licenses to incumbents has expired, up until now, Canadian officials would likely still have to allow for the transfer control of new entrant set aside spectrum to incumbents. For instance, in 2013 Industry Canada blocked TELUS' repeated attempts to purchase Mobilicity. See "Canada again blocks TELUS-Mobilicity spectrum deal," Reuters, October 30, 2013, available at: http://www.reuters.com/article/2013/10/30/us-telecoms-minister-idUSBRE99T0YG20131030 (last visited February 4, 2014).

165 For instance, a carrier could deploy 10 MHz of 700 MHz spectrum.

Table C-6. Network Model Assumptions On Chronology

Property		2012	2013	2014	2015	2016	2017
LTE Coverage	[1]	Estimated	Increases linearly to reach 2012 HSPA+ coverage by 2017				
Traffic	[2]	Calibrated	Increases by 25% annually				
Market Share Claimed by New Entrant	[3]	0%	0%	Varies by province & carrier			
Cost Analysis	[4]	Costs grown to PV 2014		Present	Costs discounted to PV 2014		

[1] See Appendix Table C-I ("LTE Coverage By Province").
[2] Brattle group assumption based on Cisco traffic projections and LTE growth assumptions.
[3] Brattle group assumption based on logit model.
[4] See Profitability Analysis.

4. Output

Table C-7 shows the predicted number of capacity and coverage sites for every combination of carrier, experiment, and year. The "base" level of spectrum refers to each carrier's spectrum holdings as of 2012. As discussed, the amount of additional spectrum available is likely to depend on whether an additional nationwide carrier emerges. The other important distinction between the scenarios in which an additional nationwide carrier emerges and the status quo without an additional carrier is the market share potentially lost to the new carrier.

We assume the additional cell sites are built as needed between 2012 and 2017 to expand the footprint of the LTE network and keep pace with growth in data traffic. Consequently, these additional cell sites represent a stream of cell sites built over five years. We assume each cell site costs $150,000 to build, and the NPV of operating the cell site for 10 years is equal to the initial cost of the cell site.[166] The NPV is then discounted back to the year of this report, 2014.

[166] The cost of the initial cell site is consistent with Wind Mobile, which reportedly built cell sites for an average of $150,000 per site. (See, David Lambert, "Wind Mobile Could Be the Real Deal," Canaccord Adams, December 10, 2009, p. 5.) Similarly, JP Morgan's estimates costs of $100,000 to $200,000 per cell site. See, JP Morgan September 20, 2013, p. 22.

The U.S. Federal Communications Commission estimates that the NPV of operating a cell site for 20 years is 1.9 times the initial cell site cost. (See the initial capex and ongoing costs for the last mile and second mile in Exhibit 4-AB in: FCC, "The Broadband Availability Gap," OBI Technical Paper No. 1, April 2010, p. 81.) Assuming a 3% annual growth in operating cost and a 5% discount rate, the FCC's 20 year estimate suggests that operating expenditure in year 1 is roughly 11% of Capex. Taking the NPV of operating the cell site over 10 years, and assuming that a discount rate of 8% is an appropriate cost of capital for a commercial carrier, suggests that the present value of the operating costs over 10 years is roughly equal to the initial cell site cost.

Table C-7. Predicted Cell Sites For All Network Model Experiments

		Experiment	Emerging National Carrier 2013 [1]	2014 [2]	2015 [3]	2016 [4]	2017 [5]	No Fourth Carrier 2013 [6]	2014 [7]	2015 [8]	2016 [9]	2017 [10]
Bell	Coverage Cells		423	653	1,012	1,658	3,633	423	653	1,012	1,658	3,633
	Capacity Cells	Base	2,008	2,196	2,606	3,104	3,697	2,008	2,325	2,779	3,321	3,958
		Base + 10	2,008	2,196	2,214	2,229	2,402	2,008	2,025	2,054	2,175	2,451
		Base + 20	2,008	2,196	2,206	2,216	2,216	2,008	2,025	2,036	2,050	2,054
		Base + 30	-	-	-	-	-	2,008	2,025	2,032	2,039	2,039
Rogers	Coverage Cells		965	1,575	2,752	5,175	10,743	965	1,575	2,752	5,175	10,743
	Capacity Cells	Base	3,753	4,147	4,874	5,781	6,923	3,753	4,351	5,142	6,150	7,386
		Base + 10	3,753	4,147	4,173	4,203	4,604	3,753	3,768	3,808	4,130	4,761
		Base + 20	3,753	4,147	4,158	4,177	4,177	3,753	3,768	3,785	3,805	3,850
		Base + 30	-	-	-	-	-	3,753	3,768	3,777	3,791	3,791
TELUS	Coverage Cells		611	960	1,866	4,340	11,106	611	960	1,866	4,340	11,106
	Capacity Cells	Base	2,266	2,467	2,838	3,270	3,922	2,266	2,606	3,014	3,490	4,215
		Base + 10	2,266	2,467	2,469	2,521	2,689	2,266	2,278	2,333	2,458	2,809
		Base + 20	2,266	2,467	2,467	2,467	2,504	2,266	2,278	2,278	2,310	2,397
		Base + 30	-	-	-	-	-	2,266	2,278	2,278	2,278	2,315

Source: The Brattle Group Analysis.
All experiments yield the same number of coverage sites for a given carrier because coverage expansion is not dependent on entry or spectrum in this model.

Appendix D. Verizon Event Study

In addition to the main Verizon event study regression results presented in Table 7 of the report, we also test several sensitivity specifications.

In the first set of sensitivities, we test two-day and three-day event windows. The two-day event window includes dummy variables equal to one on the day of the event and the trading day before the event. The three-day event window includes dummy variables equal to one on the day of the event, the trading day before the event, and the trading day after the event. These results are presented in Table D-1.

Table D-1. Event Study Regression Coefficients - Event Window Sensitivities
Period 1/4/2012 to 9/4/2013

	One-Day Event Windows			Two-Day Event Windows			Three-Day Event Windows		
	Rogers	BCE	TELUS	Rogers	BCE	TELUS	Rogers	BCE	TELUS
S&P TSX Composite Index Daily Return (%)	0.423***	0.329***	0.409***	0.484***	0.361***	0.467***	0.492***	0 361***	0.481***
	(0.0826)	(0.0458)	(0.0610)	(0.0863)	(0.0483)	(0 0683)	(0.0864)	(0.0491)	(0 0680)
One-Day Window Event 1	-0 00131	0.0165**	0.00310						
	(0.0121)	(0 00670)	(0.00892)						
One-Day Window Event 2	0.0120	0 00201	0.0116						
	(0.0121)	(0 00670)	(0.00893)						
One-Day Window Event 3	-0 0803***	-0.0392***	-0.0786***						
	(0.0121)	(0 00670)	(0.00892)						
One-Day Window Event 4	0 00663	-0 00576	-0.00974						
	(0.0121)	(0 00670)	(0.00892)						
One-Day Window Event 5	0 0397***	0.0153**	0.0450***						
	(0.0121)	(0 00670)	(0.00892)						
One-Day Window Event 6	0 0641***	0.0362***	0.0642***						
	(0.0121)	(0 00670)	(0.00893)						
Two-Day Window Event 1				-0 00267	0.00664	-7.14e-05			
				(0 00893)	(0.00499)	(0.00706)			
Two-Day Window Event 2				-0 00134	0 000172	0.00627			
				(0 00895)	(0.00500)	(0.00708)			
Two-Day Window Event 3				-0.0437***	-0.0175***	-0.0378***			
				(0 00894)	(0.00500)	(0.00707)			
Two-Day Window Event 4				0 00535	-0.00558	-0.00615			
				(0 00893)	(0.00500)	(0.00707)			
Two-Day Window Event 5				0.0207**	0.00721	0 0150**			
				(0 00893)	(0.00499)	(0.00706)			
Two-Day Window Event 6				0.0327***	0.0158***	0.0208***			
				(0 00893)	(0.00499)	(0.00706)			
Three-Day Window Event 1							0 00359	0.00306	-0.00259
							(0.00731)	(0.00415)	(0.00576)
Three-Day Window Event 2							0 00461	-0.00141	-0.00526
							(0.00731)	(0.00415)	(0.00576)
Three-Day Window Event 3							-0.0389***	-0.00928**	-0.0360***
							(0.00732)	(0.00416)	(0.00577)
Three-Day Window Event 4							-0.000917	-0.00594	-0.00494
							(0.00732)	(0.00416)	(0.00577)
Three-Day Window Event 5							0 0131*	0.00373	0.00664
							(0.00731)	(0.00416)	(0.00576)
Three-Day Window Event 6							0.0221***	0 00811*	0.0108*
							(0.00731)	(0.00415)	(0.00576)
Constant	0.000456	0.000243	0 000486	0.000493	0 000266	0 000573	0.000519	0 000311	0.000786
	(0.000593)	(0.000329)	(0 000438)	(0.000623)	(0 000349)	(0 000493)	(0.000629)	(0 000357)	(0.000496)
Observations	420	420	420	420	420	420	420	420	420
R-squared	0.222	0.247	0 342	0.152	0.165	0.177	0.149	0.135	0.181

Notes:
[1]: Two-day event windows include the event day and the previous trading day. Three-day event windows include the event day, previous trading day, and subsequent trading day.
[2]: Standard errors in parentheses.
[3]: Significance:*** p<0 01, ** p<0.05, * p<0.1

In the second set of sensitivities, we test alternate periods over which the regression is run. In the main specification presented in Table 7, the regressions are run over a period from January 4, 2012 to September 4, 2013. We also test regressions that are run over periods starting on July 3, 2013, and January 2, 2013. These results are presented in Table D-2.

Table D-2. Event Study Regression Coefficients - Period Sensitivities
One-Day Event Windows

	January 4, 2012 Start			July 3, 2013 Start			January 2, 2013 Start		
	Rogers	BCE	TELUS	Rogers	BCE	TELUS	Rogers	BCE	TELUS
S&P TSX Composite Index Daily Return (%)	0.423***	0.329***	0.409***	0.517***	0.395***	0.490***	0.724***	0.480***	0.596***
	(0.0826)	(0.0458)	(0.0610)	(0.104)	(0.0571)	(0.0820)	(0.158)	(0.0721)	(0.111)
One-Day Window Event 1	-0.00131	0.0165**	0.00310	-0.00170	0.0164**	0.00312	-0.00144	0.0162**	0.00301
	(0.0121)	(0.00670)	(0.00892)	(0.0119)	(0.00658)	(0.00945)	(0.0139)	(0.00636)	(0.00983)
One-Day Window Event 2	0.0120	0.00201	0.0116	0.0112	0.00163	0.0113	0.0106	0.00105	0.0107
	(0.0121)	(0.00670)	(0.00893)	(0.0119)	(0.00659)	(0.00946)	(0.0139)	(0.00638)	(0.00985)
One-Day Window Event 3	-0.0803***	-0.0392***	-0.0786***	-0.0801***	-0.0389***	-0.0780***	-0.0785***	-0.0386***	-0.0775***
	(0.0121)	(0.00670)	(0.00892)	(0.0119)	(0.00658)	(0.00945)	(0.0139)	(0.00637)	(0.00984)
One-Day Window Event 4	0.00663	-0.00576	-0.00974	0.00599	-0.00602	-0.00994	0.00568	-0.00647	-0.0103
	(0.0121)	(0.00670)	(0.00892)	(0.0119)	(0.00658)	(0.00945)	(0.0139)	(0.00637)	(0.00984)
One-Day Window Event 5	0.0397***	0.0153**	0.0450***	0.0390***	0.0150**	0.0448***	0.0386***	0.0145**	0.0444***
	(0.0121)	(0.00670)	(0.00892)	(0.0119)	(0.00658)	(0.00945)	(0.0139)	(0.00637)	(0.00984)
One-Day Window Event 6	0.0641***	0.0362***	0.0642***	0.0633***	0.0358***	0.0639***	0.0625***	0.0352***	0.0632***
	(0.0121)	(0.00670)	(0.00893)	(0.0119)	(0.00659)	(0.00946)	(0.0140)	(0.00638)	(0.00986)
Constant	0.000456	0.000243	0.000486	0.000656	0.000192	0.000298	-2.59e-05	0.000235	0.000202
	(0.000593)	(0.000329)	(0.000438)	(0.000701)	(0.000387)	(0.000555)	(0.00108)	(0.000495)	(0.000765)
Observations	420	420	420	295	295	295	170	170	170
R-squared	0.222	0.247	0.342	0.292	0.320	0.395	0.358	0.459	0.510

Notes:
[1]: All periods end on 9/4/2013.
[2]: Standard errors in parentheses.
[3]: Significance:*** p<0.01, ** p<0.05, * p<0.1

Appendix E. Report Authors' Curriculum Vitae

Kevin C. Hearle
Principal

Washington, D.C. +1.202.955.5050 Kevin.Hearle@brattle.com

Kevin Hearle specializes in applying corporate finance and accounting expertise to the analyses of antitrust and other competition issues. His experience includes determining the economic profitability of companies, products, and assets; identifying and measuring efficiencies realized from mergers and acquisitions; evaluating the financial viability of firms or assets; and assessing whether prices may be construed as predatory. He has provided expert testimony on corporate valuation, cost of capital, and "ability to pay" issues. Mr. Hearle also develops quantitative models of industry competition and pricing. He is expert at processing, validating, and analyzing large computerized data sets created for such quantitative projects.

His clients have included airlines, cable television owner/operators, cellular telecommunications firms, hospitals, state governments, and firms in aerospace, aircraft services, shipping, tobacco, building materials, credit card, construction, pharmaceutical, cruise line, electronic brokerage, electric utility, automobile, elevator, electronic media, beer, x-ray film, and information processing businesses.

In connection with antitrust matters, Mr. Hearle manages the development of economic and statistical models of industry competition, market share, and pricing. He is expert at processing, validating, and analyzing very large computerized data sets created for such economic and statistical projects.

Mr. Hearle first joined Brattle in 2003 and re-joined in 2010 after briefly working as an independent consultant. Prior to that, Mr. Hearle was Chief Financial Officer, Treasurer, and Vice President of Competition Economics, Inc., which he co-founded. Previously, Mr. Hearle was a Vice President of Econsult Corporation and a Project Manager with ICF Incorporated, where he managed the preparation of regulatory impact studies analyzing the economic and financial costs of federal environmental regulations. He also has been a programmer/analyst with Hewlett Packard Co.

EXPERIENCE

Mr. Hearle's financial experience includes:

- estimating firms' cost of capital, profitability, rates of return, and cash flow;
- valuing companies, assets, and intangibles;
- providing expert testimony on valuation, cost of capital, and financial viability issues;
- measuring and valuing damages in the context of litigation or arbitration;

- performing financial feasibility studies and estimating break-even prices;
- evaluating whether companies or assets may be considered "failing" as defined by U.S. antitrust authorities;
- evaluating and critiquing a “trader’s model” used to estimate damages for a securities litigation matter; and
- examining whether international transfer prices pass IRS "arm's-length" standards.

Examples of his experience include the following:

Valuation Analysis and Corporate Recovery

- Estimating market values of individual cellular telecommunications properties in California, including adjustments to remove the impact of FCC licenses on value.
- For private litigation involving pharmaceutical companies, replicating and extending the plaintiff's financial damages model and producing alternative corrected damage estimates.
- Evaluating a damage model prepared for an aerospace services firm and developing a series of alternative analyses which corrected various conceptual and data errors.
- Estimating the value of damages that could be owed in a multi-billion dollar corporate litigation among financial institutions.
- Preparing a computerized financial model for evaluating potential damages in connection with litigation involving devices for quieting jet aircraft engines.
- Reviewing damage calculations prepared for a supplier of bus air conditioning units, and evaluating damages after implementing corrections for methodological and data errors.
- Estimating the market value of a railroad transportation leasing firm using market multiple and discounted cash flow methods.
- Reviewing and critiquing damages analyses prepared in connection with a class action litigation involving three major domestic airlines.

Financial Analysis

- For an antitrust matter, developing cash flow projections for a hospital facility under alternative patient census levels, ownership, and financing arrangements to assess whether the hospital's assets could be considered "failing".

- Serving as a principal analyst in estimating the "fair" value of a cable TV programming service.
- For a securities litigation matter, replicating the "trader model" used to estimate share trading during the damages period and demonstrating that the plaintiffs' expert had not adopted parameters that minimized the alleged damages.
- Developing financial models to prove that clients' decisions to shut production capacity were profitable, which justified those decisions to government investigators.
- In connection with an FTC follow-up investigation of a merger of two hospitals, preparing and presenting analyses of the profitability and financial viability of the hospitals but for the merger, and of the value of "efficiencies" realized from the merger.
- Preparing reports estimating the cost of capital for cellular properties in California, including: (1) determining the cost of equity using the Capital Asset Pricing Model, (2) estimating cost of debt from bond yield data, and (3) utilizing the relative contribution of debt and equity in the firms' overall capitalization.
- Estimating an aerospace manufacturer's "average variable costs" of producing engine spare parts to evaluate whether planned price reductions could be construed as predatory.
- Evaluating whether price discounts offered by a manufacturer to its authorized service facilities were justified by the costs of services these facilities performed on behalf of the manufacturer.
- For an international transfer pricing matter, analyzing the comparability of two U.S. distributors of foreign autos and performing accounting and financial adjustments to improve the comparability of profit measures.
- Developing a discounted cash flow (DCF) financial model of a natural gas pipeline for use in evaluating alternative rate setting mechanisms.
- Estimating DCF rates of return and break-even prices for manufacturers of jet engines, under alternative assumptions for expected future production volumes.
- Analyzing whether maintenance contracts offered by a regional Bell company were priced fairly relative to the costs of non-contract repairs.
- Developing a computerized, Monte Carlo financial simulation model for evaluating the financial feasibility of a hazardous waste treatment and disposal facility.

- Evaluating the potential market for aircraft engine "hushkits" designed to comply with U.S. aircraft noise regulations, focusing on financial analyses of methods available to aircraft owners for complying with the regulations.
- Evaluating proposals to install a cable television system, including developing computerized DCF models to simulate rates of return under unexpected contingencies, such as reduced market penetrations.
- Estimating the cost of capital for a U.S. subsidiary of a major foreign car manufacturer, including estimating rates of return for comparable companies.
- Estimating the after-tax rate of return that companies required for purchasing and operating vessels for carrying iron ore on the Great Lakes during the 1960's and 1970's.
- Evaluating whether a media company's decision to shut down a division in the context of a merger was financially justified.
- Estimating average and incremental costs per customer for a television monitoring business.

Analyses of Industry Competition and Pricing

- For a major U.S. airline, identifying airport-to-airport and city-to-city markets which might present competitive issues in connection with potential mergers between the airline and each of 5 other U.S. carriers, then investigating how the potential competitive problems might be solved.
- Developing and programming a computer model of geographic product flows for a building material in order to estimate geographic markets under simulated price changes.
- Developing a database of hospital patient admissions and health insurance company claims, and using the database to profile hospitals shares of patient flows in Southern Virginia.
- Analyzing patient origin data for hospitals located around Orlando, Florida, computing various measures of "market" concentration for hospital services in this area, and testing the sensitivity of these measures to alternative definitions of the geographic or product "market".
- Processing and analyzing hospital patient discharge data to determine whether a hospital's claims of monopolistic behavior by a competing facility could be justified.
- Profiling the domestic operations of two leading U.S. airlines in terms of number of routes, passengers, and geographic concentration, focusing on airport-to-airport, city-to-city, and state-to-state markets on which the airlines had high passenger shares.

- Participating in analyses of the validity of claims that U.S. air carriers used computerized reservation systems illegally to signal changes in air fares.
- Developing data and analyses for computing passenger yields and market shares of a regional U.S. airline to determine whether the company possessed significant geographic market power.
- For a planned merger of two U.S. carriers, identifying airport-to-airport and city-to-city routes where the carriers had overlapping service and which might pose competitive problems if the merger were consummated, and identifying new connecting service opportunities created by combining the carriers' non-stop service offerings.
- Analyzing sales and invoice databases of a major pharmaceutical company for evidence of differential price discounts among various classes of customers.
- In connection with a private antitrust matter involving major cigarette manufacturers, creating and analyzing data sets to measure the effectiveness of an in-store retail promotion program.
- Developing data and analyses to demonstrate consumer benefits deriving from an alliance between two major U.S. air carriers.
- Preparing and analyzing data sets for comparing the pricing of U.S. Treasury securities offered on two electronic trading platforms, to evaluate whether incentives established by the owners of one of the platforms had "harmed" the customers of that platform.

EDUCATION

Kevin Hearle received a B.A. in Economics (high honors) from Swathmore College and a M.B.A. from Stanford University.

GIULIA MCHENRY, PHD

Associate

Washington, DC | +1.202.419.3377 | Giulia.McHenry@Brattle.com

Dr. Giulia McHenry joined The Brattle Group as an Associate in 2010. Her primary areas of expertise are telecommunication and media, and antitrust litigation. She has consulted on numerous telecommunication matters and numerous expert reports related to spectrum management and valuation, broadband deployment, regulatory proceedings, Universal Service Fund, and competition policy. Her work has included advising on nearly all aspects of the upcoming FCC Incentive Auction, from predicting market-by-market prices for TV broadcast licenses and estimating wireless broadband license values, to identifying the implications of key auction rules. She has filed ex parte economic analyses at the Federal Communications Commission and presented to staff at the U.S. Congress on behalf of clients in various regulatory proceedings.

Prior to joining Brattle, she was a senior economist at the Government Accountability Office (GAO), where she conducted economic analysis related to U.S. international policy, including trade and trade promotion, global financial linkages, and international development. Dr. McHenry received her Ph.D. in economics from the University of Maryland in 2009. Her primary fields of specialization were microeconomics, both applied and empirical methods, and behavioral economics. In particular, she focused on network theory and industrial organization. Her dissertation addressed issues related to social networking and entrepreneurship, and she has authored papers on how the structure of a social network affects the ability of entrepreneurs within the network to find a well-suited partner and be successful. The models she developed offer a framework with which to study how relative network positions affect payoffs and incentives within a network.

Prior to graduate school, Dr. McHenry worked as an analyst at NERA Economic Consulting where she gained extensive experience in price-fixing litigation and merger investigations.

EDUCATION

Ph.D. and M.A. in Economics, University of Maryland at College Park
B.A. from Wesleyan University

AREAS OF EXPERTISE

- Telecommunications and Media
- Antitrust

PUBLICATIONS \ WORKING PAPERS

"Incentivizing Federal Users: Tying Fees to Spectrum Value," with Coleman Bazelon, U.S. House of Representatives Committee on Energy and Commerce, filed comment April 25, 2014.

"Spectrum Sharing: Taxonomy and Economics," with Coleman Bazelon, Office of Science and Technology Policy, filed comment March 18, 2014.

"Spectrum Sharing: Taxonomy and Economics," with Coleman Bazelon, sponsored by Verizon, February 6, 2014.

"The Economics of Spectrum Sharing," with Coleman Bazelon, TPRC41: The Research Conference on Communication, Information, and Internet Policy, September 2013.

"Violating Your Privacy," with Coleman Bazelon, TPRC41: The Research Conference on Communication, Information, and Internet Policy, September 2013.

"Spectrum Value," with Coleman Bazelon, Telecommunications Policy Journal, September 2013.

"Alaska Mobile Broadband Cost Model," FCC Filing with William P. Zarakas, Ex Parte Comments, WC Docket Nos. 10-90 and 10-208, February 15, 2013.

"An Engineering and Economic Analysis of the Prospects of Reallocating Radio Spectrum from the Broadcast Band through the Use of Voluntary Incentive Auctions," with Coleman Bazelon and Charles Jackson, Telecommunications Policy Research Conference, September 2011.

"The Facebook Effect: How Congress is Using Social Networks to Strengthen Ties to Constituents—And How it Could be Doing it Better," with Rich Thau, Congressional Institute, 2009.

"Friends, Partners and Competitors: The Impact of Social Networks on Entrepreneurs," 2009. Paper developed a discrete matching model that provides a framework to evaluate how relative network positions affect payoffs and incentives within a network.

"Making New Friends: Searching an Endogenous Social Network," 2009. Paper develops a continuous matching model that integrates findings from ("Friends") to analyze costly network search, and shows why broad, low-cost networks such as LinkedIn and Facebook are inefficient.

"Networks and Entrepreneurship: Partnering Through Social Networks," 2007.

PRESENTATIONS

Spectrum Value, 41th Annual Telecommunications Policy Research Conference (TPRC), Arlington, VA, September 28, 2013.

Incentive Auction Debate – Are the Stakes too High for Broadcasters? and *VC's and Investors Buying into White Spaces*, The Super Wi-Fi & Shared Spectrum Summit, Las Vegas, August 28, 2013.

Economics Research Challenges & Opportunities, Wireless Spectrum Research and Development (WSRD) Workshop IV, Promoting Economic Efficiency in Spectrum Use: the economic and policy R&D Agenda, MIT, April 24, 2013.

FCC Incentive Auction Rules-Estimating Clearing Prices and Policy Impacts, SNL Kagan Webinar, February 27, 2013.

Spectrum Value, 40th Annual Telecommunications Policy Research Conference (TPRC), Arlington, VA, September 22, 2012.

The Facebook Effect: How Congress is Using Social Networks to Strengthen Ties to Constituents—And How it Could be Doing it Better, with Rich Thau. Presented at Congressional Institute meetings for Members of Congress in January 2009 and Chiefs of Staff in March 2009.

PROFESSIONAL ACTIVITIES

- Member of the Federal Communications Bar Association
- Referee for *Information Economics and Policy*

ACADEMIC HONORS AND FELLOWSHIPS

Graduate Assistantship, Department of Economics University of Maryland, 2005 - 2009
Graduate Fellowship, Department of Economics, University of Maryland, 2004 - 2005
Phi Beta Kappa, Wesleyan University, 2001
Davenport Study Grant for Senior Honors Thesis, Wesleyan University, 2000 – 2001

AWARDS AND HONORS

The Bill Moss Prize for Excellence in Mentoring and Developing People, The Brattle Group, 2013.

Office: Washington, DC ♦ Phone: +1.202-955-5050 ♦ Email: James.Reitzes@brattle.com

Dr. James D. Reitzes received his B.A. in economics and history from Stanford University in 1978, and his Ph.D. in economics from the University of Wisconsin in 1986. Dr. Reitzes specializes primarily in providing economic analyses and expert testimony pursuant to antitrust litigation (including price-fixing, attempted monopolization, and merger matters) and regulatory proceedings in the energy and transportation sectors.

Dr. Reitzes has provided expert analysis and testimony in energy-related competition and regulatory matters before the Federal Energy Regulatory Commission, state public utility commissions, and federal antitrust agencies. In the transportation sector, he has offered expert analysis and testimony in proceedings involving the U.S. Department of Transportation, U.S. Department of Justice, the European Commission, the European Court of First Instance, and national antitrust authorities. He also has provided economic consulting services to clients in the United States, Canada, the European Union, South America, and South Africa.

From 1988 to 1993, Dr. Reitzes served in the Divisions of Antitrust and Economic Policy Analysis at the Federal Trade Commission. Dr. Reitzes was involved in merger investigations and other inquiries into alleged anticompetitive conduct. He provided comments and testimony on behalf of the FTC regarding competitive issues in the ocean shipping and banking sectors. At the FTC, Dr. Reitzes's research provided analytical foundations for the "unilateral effects" theory of merger behavior.

Dr. Reitzes joined the Law & Economics Consulting Group in 1993, where he contributed economic analyses for litigation, regulatory proceedings, and administrative hearings. His responsibilities included providing economic analyses of the competitive effects of mergers during the HSR review process (and subsequent challenges by the U.S. Department of Justice); assessing market conditions in FCC proceedings and telecommunications litigation; and, evaluating injury in antidumping and subsidy actions before the U.S. International Trade Commission.

In 1995, Dr. Reitzes joined Ernst & Young LLP, where he continued to provide expert economic analysis and testimony related to litigation in the areas of antitrust, intellectual property, and international tax disputes. His engagements included merger actions in the transportation sector and Robinson-Patman matters involving the publishing industry.

Dr. Reitzes joined *The Brattle Group* as a Principal in April 1998. Most recently, Dr. Reitzes has been involved in matters of alleged price fixing and attempted monopolization; analyses of mergers, market power, and procurement strategies in the energy industry (for proceedings before FERC, antitrust

agencies, and state commissions); and assessments of the economic impact of international aviation liberalization and the competitive effects of airline alliance expansion.

Dr. Reitzes has authored several articles on firm strategies with respect to pricing, quality, R&D investment, and merger behavior, published in leading economic and legal journals. He also is an author of a book that assesses the domestic impact of U.S. international trade policies with respect to steel, apparel, textiles, and petroleum.

INDUSTRY EXPERIENCE

Dr. Reitzes possesses specialized experience in a variety of industries, particularly *electricity, aviation, ocean shipping, natural gas, telecommunications, and steel. Electricity* experience includes analyzing the competitive impact of mergers and acquisitions, assessing default service procurement strategies, examining consumer switching behavior in retail power markets, simulating future wholesale energy prices, formulating protocols for monitoring electric power markets, assessing market reorganization plans, and assessing the benefits provided by regional transmission organizations in proceedings involving state public utility commissions, the Federal Energy Regulatory Commission, and the antitrust agencies. Dr. Reitzes also has designed and managed RFP and auction processes to purchase or sell electric power, capacity, transmission rights, and renewable energy credits. *Aviation* experience includes the economic analysis of expanded antitrust immunity for airline alliances in proceedings before the Department of Transportation; a study assessing the economic impact of forming an open aviation area between the United States and the European Union; a study assessing the effectiveness of Dutch international aviation policy; and a study assessing proposed rule changes involving computer reservation systems (CRSs) and their effect on competition in the CRS, airline, and travel agency industries. *Ocean shipping* expertise involves expert testimony regarding the extent of market power exercised by liner conferences, expert analysis related to mergers in the ocean shipping industry, and analysis of the competitive impact of particular provisions in conference rate agreements. *Natural gas* experience involves analyzing the competitive effects of mergers involving electric and natural gas assets from both a horizontal and vertical perspective, and the formation of optimal tariff schemes to permit cost recovery and maximize use of natural gas distribution resources. *Telecommunications* experience includes antitrust review of mergers and acquisitions involving providers of wireless telephony, video programming, and cable television distribution. *Steel* industry expertise involves analyses of the economic impact of foreign imports on U.S. domestic producers in proceedings before the U.S. International Trade Commission.

PAPERS AND PUBLICATIONS

Journals

"Domestic Versus International Capital Mobility: Some Empirical Evidence," with Donald J. Rousslang, *Canadian Journal of Economics*, Vol. 21, No. 2 (May 1988): 312-323.

"The Impact of Quotas and Tariffs on Strategic R&D Behavior," *International Economic Review*, Vol. 32, No. 4 (November 1991): 985-1007.

"Anticompetitive Effects of Mergers in Markets with Localized Competition," with David T. Levy, *Journal of Law, Economics, and Organization*, Vol. 8, No. 2 (April 1992): 427-440.

"Quality Choice, Trade Policy, and Firm Incentives," *International Economic Review*, Vol. 33, No. 4 (November 1992): 817-835.

"Basing-Point Pricing and Incomplete Collusion," with David T. Levy, *Journal of Regional Science*, Vol. 33. No. 1 (February 1993): 27-35.

"Ocean Shipping Economics: Comment," *Contemporary Policy Issues*, Vol. 11, No. 3 (July 1993): 81-85.

"Product Differentiation and the Ability to Collude: Where Being Different Can Be an Advantage," with David T. Levy, *Antitrust Bulletin*, Vol. 38, No. 2 (Summer 1993): 349-368.

"Antidumping Policy," *International Economic Review*, Vol. 34, No. 4 (November 1993): 745-763 [reprinted in Douglas R. Nelson and Hylke Vandenbussche editors, *The WTO and Anti-Dumping: Volume 1* (Cheltenham, UK: Edward Elgar Publishers, 2005): 392-410].

"The Importance of Localized Competition in the 1992 Merger Guidelines: How Closely Do Merging Firms Compete?" with David T. Levy, *ABA Antitrust Law Journal*, Vol. 62, No. 3 (Spring 1994): 695-716.

"Market-Share Quotas," with Oliver R. Grawe, *Journal of International Economics*, Vol. 36, No. 3/4 (May 1994): 431-447.

"Price Discrimination and Mergers," with David T. Levy, *Canadian Journal of Economics*, Vol. 28, No 2 (May 1995): 427-436.

"In the Matter of Weyerhaeuser Company: The Use of the Hold-Separate Order in a Merger with Horizontal and Vertical Effects," with Robert P. Rogers and Laurence Schumann, *Journal of Regulatory Economics*, Vol. 11, No. 3 (May 1997): 271-289.

"Market Power and Collusion in the Ocean Shipping Industry: Is a Bigger Cartel a Better Cartel?" with Paul S. Clyde, *Economic Inquiry*, Vol. 36, No. 2 (April 1998): 292-304.

"Is it Efficient to Impose Costs on Small-Volume Equity Traders?" with Paul S. Clyde, *International Journal of the Economics of Business*, Vol. 6, No. 1 (April 1999): 81-92.

"Lessons from the First Year of Competition in the California Electricity Markets," with Robert Earle, Philip Hanser, and Weldon Johnson, *The Electricity Journal*, Vol. 12, No. 8 (October 1999): 57-76.

"Entry Policy and Entry Subsidies," with Oliver R. Grawe, *Review of International Economics,* Vol. 7, No. 4 (November 1999): 715-731.

"Deregulation and Monitoring of Electric Power Markets," with Robert L. Earle and Philip Q Hanser, *The Electricity Journal*, Vol. 13, No. 8 (October 2000): 11-25.

"Strategic Pricing When Electricity Is Storable," with Alfredo Garcia and Ennio Stachetti, *Journal of Regulatory Economics*, Vol. 20, No. 3 (November 2001): 223-247.

"Rolling Seas in Liner Shipping," with Kelli L. Sheran, *Review of Industrial Organization*, Vol.20, No. 1 (February 2002): 51-59.

"Regional Interactions in Electricity Prices in the Eastern United States," with Gregory R. Leonard, Adam C. Schumacher, and James G. Bohn, in Michael A. Crew and Joseph C. Schuh editors, *Markets, Pricing, and Deregulation of Utilitie*s (Boston: Kluwer Academic Publishers, 2002): 109-142.

"Designing Standard-Offer Service to Facilitate Electric Retail Restructuring, with Lisa V. Wood, J. Arnold Quinn, and Kelli L. Sheran, *The Electricity Journal*, Vol. 15, No. 9 (November 2002): 34-51.

"Can Mergers to Monopoly, Price Fixing, and Market-Division Agreements Raise Welfare?" with Paul S. Clyde, *International Journal of the Economics of Business*, Vol. 11, No. 1 (February 2004): 69-90.

"Forward and Spot Prices in Electricity and Gas Markets: Does 'Storability' Matter?" with J. Arnold Quinn and Adam C. Schumacher, in Michael A. Crew and Menahem Spiegel editors, *Obtaining the Best from Regulation and Competition* (Boston: Kluwer Academic Publishers, 2005): 109-135.

"Incentive Contracts for Infrastructure, Litigation and Weak Institutions" with Alfredo Garcia and Juan Benavides, *Journal of Regulatory Economics*, Vol. 27, No. 1 (January 2005): 5-24.

"Dynamic Pricing & Learning in Electricity Markets," with Alfredo Garcia and Enrique Campos, *Operations Research*, Vol. 53, No. 2 (March-April 2005): 231-241.

"Estimating the Economic 'Trade' Value of Increased Transmission Capability," with Andrew N. Kleit, *The Electricity Journal*, Vol. 19, No. 2 (March 2006): 69-78.

"International Perspectives on Electricity Market Monitoring and Market Power Mitigation," with Jose A. Garcia, *Review of Network Economics*, Vol. 6, No. 3 (September 2007): 397-424.

"Downstream Price-Cap Regulation and Upstream Market Power," *Journal of Regulatory Economics*, Vol. 33, No. 2 (April 2008): 179-200.

"Airline Alliances and Systems Competition," with Diana Moss, *Houston Law Review*, Vol. 45, No. 2 (Summer 2008): 293-332.

"The Effectiveness of FERC's Transmission Policy: Is Transmission Used Efficiently and When Is It Scarce?" with Andrew N. Kleit, *Journal of Regulatory Economics*, Vol. 34, No. 1 (August 2008): 1-26.

"Competition for Exclusive Customers: Comparing Equilibrium and Welfare under One-Part and Two-Part Pricing," with Glenn A. Woroch, *Canadian Journal of Economics*, Vol. 41, No. 3 (August 2008): 1046-1086.

Books

The Regional Welfare Effects of U.S. Import Restraints on Apparel, Petroleum, Steel and Textiles, with Randi Boorstein, Michael Metzger, and Morris Morkre*,* Avebury Press, 1996.

Completed Studies

"Case Studies of the Price Effects of Horizontal Mergers," *Staff Report of the Federal Trade Commission,* April 1992, with coauthors.

"The Effectiveness of Collusion under Antitrust Immunity—The Case of Liner Shipping Conferences," *Staff Report of the Federal Trade Commission*, December 1995, with coauthor.

"The Effectiveness of Dutch Airport Transport Policy," study prepared for the Dutch Ministry of Transport, December 2002, with coauthors.

"The Economic Impact of an EU-US Open Aviation Area," study prepared for the European Commission - Directorate-General for Energy and Transport, December 2002, with coauthors.

"Study to Assess the Potential Impact of Proposed Amendments to Council Regulation 2299/89 with regard to Computerised Reservation Systems," study prepared for the European Commission - Directorate-General for Energy and Transport, October 2003, with coauthors.

TESTIMONY/EXPERT REPORTS

Testimony before the Advisory Commission on Conferences in Ocean Shipping, 1991, relating to an econometric analysis of the determinants of ocean freight rates, and the conclusions of that study with respect to the existence of market power in ocean shipping.

Expert Submission - Appendix J, Volume 1, Prehearing Brief on Behalf of Petitioner, Certain Flat Rolled Carbon Steel Products, June 21, 1993, U.S. International Trade Commission Investigation Nos. 701-TA-319-332, 334, 336-342, 344, and 347-353 (final); 731-TA-573-579, 581-592, 594-597, 599-609, and 612-619 (final). Analysis included a critique of methods used to evaluate domestic injury in trade cases. Also authored part of submission for post-hearing brief.

Expert Report Submitted to the European Court of First Instance on Behalf of the European Commission relating to the Petition of the Transatlantic Agreement to Annul the Commission's Decision of October 19, 1994, including a rebuttal of the expert economic analysis offered by the members of the Transatlantic Agreement in support of their collective restrictions on capacity utilization and their coordinated activity in setting certain types of freight rates.

Testimony in the matter of *Henry H. Godfrey v. Benjamin F. Hofheimer, III, et. al.*, 1995, on behalf of defendant relating to the appropriate calculation of damages in a breach-of-contract dispute.

Report Submitted to the Environmental Protection Agency, 2000, on behalf of a trade group of aluminum smelters assessing the economic costs of revised land-disposal restriction standards for spent aluminum potliners (K088), 2000.

Expert Reports Submitted to the U.S. District Court for the District of Maryland, 2001, in the matter of *Charles River Associates Inc. v. Hale Trans, Inc.*, assessing the quality and cost effectiveness of economic expertise provided in a predatory-pricing matter.

Expert Report Submitted to the U.S. District Court for the District of Columbia, 2003, in the matter of *DAG Enterprises Inc. v. Exxon Mobil Corporation*, regarding the suitability of a prospective purchaser as an acquirer of Mobil assets under the antitrust standards used by the Federal Trade Commission.

Expert Report Submitted to the Federal Energy Regulatory Commission (Docket No. EC05-43-000) 2005 on behalf of Midwest Generation, regarding the competitive impact of the proposed merger of Exelon Corporation and Public Service Enterprise Group and the mitigation measures offered by the parties.
Expert Reports submitted to the U.S. Department of Transportation (Docket No. OST-2004-19214), 2005, on behalf of American Airlines, regarding the competitive impact of the proposed application for antitrust immunity of an airline alliance consisting of Delta, Northwest, KLM, Air France, Alitalia, and Czech Airlines.

Expert Report and Testimony before the Public Utility Commission of Texas (Docket No. 31056), 2005, on behalf of the Cities served by AEP Texas Central Company, the Texas Industrial Energy Consumers, and the Alliance for Valley Healthcare, regarding the competitiveness of an auction held to sell an ownership share in a nuclear power plant and the commercial reasonableness of the actions taken by the seller.

Expert Reports submitted to the U.S. Department of Transportation (Docket No. OST-2005-22922), 2006, on behalf of American Airlines, regarding the competitive impact of the proposed Star alliance expansion to include LOT and Swiss airlines and expand antitrust immunity between Air Canada and United Airlines.

Expert Report and Testimony before the Public Service Commission of Maryland, (Case No. 9117, Phase 1), 2007 on behalf of Potomac Electric Power Company and Delmarva Power & Light Company, regarding the risks and costs associated with portfolio procurement of electric power supplies as opposed to relying on a full-requirements auction-based procurement method.

Expert Report submitted to the Pennsylvania Public Utility Commission (Docket No. P-0072305), 2008, on behalf of Pennsylvania Power Company, regarding the risks and costs associated with different procurement methods for obtaining electric power supplies to serve default-service customers.

Expert Report and Testimony before the Public Utility Commission of Ohio (Case No. 08-936-EL-SSO), 2008, on behalf of Ohio Edison Company, The Cleveland Electric Illuminating Company, and The Toledo Edison Company, regarding the rationale for using an auction process to procure full-requirements electric power supplies for standard-service-offer customers, as well as a description of the responsibilities undertaken by myself and The Brattle Group as manager of that procurement.

Expert Report submitted to the Pennsylvania Public Utility Commission (Docket Nos. P-2009-2093053 and P-2009-2093054), 2009, on behalf of Metropolitan Edison Company and Pennsylvania Electric Company, describing the design of an RFP process for procuring solar photovoltaic alternative energy credits and the management of that process by myself and The Brattle Group, as well as an analysis of the desirability of meeting default service obligations through the auction-based procurement of full-requirements power supplies.

Various Expert Reports submitted between 2008 and 2010 to the U.S. Department of Transportation (Docket No. OST-2008-0252) and the European Commission describing the competitive impact of the proposal by the oneworld alliance to receive antitrust immunity, including various assessments of the impact on non-stop and connecting passengers that relied upon econometric analysis of airline fare data and other empirical methods.

Report submitted to the Pennsylvania Public Utility Commission, 2010, as the Independent Procurement Manager for the procurement of Solar Photovoltaic Alternative Energy Credits by Metropolitan Edison Company and Pennsylvania Electric Company, including a description of the RFP process,

a benchmarking of procurement prices against both current short-term prices and expected long-term prices for solar credits (based on a proprietary financial model), and the conformity of the procurement to the standards of least-cost procurement provided under Pennsylvania law.

Expert Reports (and Deposition) submitted to the U.S. District Court for the Middle District of Tennessee, 2012, in the matter of *Watson Carpet & Floor Covering Inc. v. Mohawk Industries Inc.*, regarding the competitive effects of a carpet manufacturer's alleged refusal to sell its products to a carpet dealer serving production homebuilders in Nashville and surrounding counties.

Expert Reports and Testimony before the Pennsylvania Public Utility Commission (Docket Nos. P-2011-2273650, P-2011-2273668, P-2011-2273669, and P-2011-2273670), 2011 and 2012, on behalf of Metropolitan Edison Company, Pennsylvania Electric Company, Pennsylvania Power Company, and West Penn Power Company, analyzing the Companies' procurement strategies for supplying default service customers, describing the design of an RFP process for procuring solar photovoltaic alternative energy credits (and the management of that process by myself and The Brattle Group), proposing an auction process for outsourcing the provision of generation service for time-of-use customers, describing an "opt-in" auction process to promote the switching of default service customers to competitive retail supply, and describing a customer referral program that is also designed to promote retail competition.

ON THE RECORD COMMENTS

"Fees for Off-Airport Rental Car Companies"—Comments on behalf of the Federal Trade Commission to the U.S. Department of Transportation, 1989.

> Comments and statistical analysis of the competitive impact of revenue-based license fees imposed by airport authorities on off-airport car rental companies.

"An Analysis of the Maritime Industry and the Effects of the 1984 Shipping Act"—Comments on behalf of the Federal Trade Commission to Congress, 1989.

> Analysis of the regulatory structure of ocean shipping under the 1984 Shipping Act and its impact on competition, pricing, and the diversity of services offered (including a statistical analysis of the determinants of liner freight rates).

"Interdistrict Transportation System Price Structure,"—Comments on behalf of the Federal Trade Commission to the Board of Governors of the Federal Reserve System, 1991.

> Comments and presentation to the staff of the Board of Governors of the Federal Reserve System relating to the competitive impact of proposed changes in the pricing of check-processing services, along with recommendations concerning alternative pricing mechanisms.

PROFESSIONAL ACTIVITIES

- Consultant to the *World Bank* on the formation of regional trading blocs and the *European Community* (DG IV) on antitrust and transportation issues.
- Advisory Board Member of the Center for Research in Regulated Industries
- Member of the Atlantic Energy Group
- Referee for the following journals: *American Economic Review, Canadian Journal of Economics, Contemporary Policy Issues, European Economic Review, International Economic Review, International Journal of the Economics of Business, Journal of Economics, Journal of Economics and Business, Journal of Economic Integration, Journal of Industrial Economics, Journal of International Economics, Journal of Regulatory Economics, Oxford Economic Papers, and Review of International Economics*.

June 21, 2013

JEREMY A. VERLINDA

Senior Associate

Washington, DC | +1.202.419.3370 | Jeremy.Verlinda@brattle.com

Dr. Verlinda specializes in industrial organization, antitrust, econometrics and statistics. He has supported testifying experts in an antitrust matter before a U.S. district court and in damages calculations before an international tribunal. Dr. Verlinda has also co-authored a report on the competitiveness of the wireless telecommunications industry at the request of a foreign competition authority (still under review).

Prior to joining The Brattle Group, Dr. Verlinda spent 8 years at the *Antitrust Division* of the *U.S. Department of Justice*, where his casework focused on monopolization claims in the payments and electricity industries, criminal price fixing in air cargo and financial markets, and merger analysis (including demand estimation and merger simulation) in the consumer goods, airlines, entertainment, and electricity industries. In electricity markets, Dr. Verlinda has particular expertise in merger simulation, including incorporation of system dispatch accounting for transmission grid and plant operating characteristics.

Dr. Verlinda received his Ph.D. in Economics from the University of California – Irvine, where his primary research examined the relationship between pricing dynamics and market structure in retail gasoline markets. Dr. Verlinda also specialized in econometrics, focusing in particular on the application of Bayesian methods to discrete choice analysis, panel and time series data, and demand estimation.

EDUCATION

Ph.D. Economics, University of California – Irvine, June 2005
Dissertation: Essays on Pricing Dynamics, Price Dispersion, and Nested Logit Modelling
B.S. Economics, University of Washington, March 1999
B.A. Business Administration, University of Washington Business School, March 1999

AREAS OF EXPERTISE

- Industrial Organization
- Antitrust (including merger and conduct analysis)
- Econometrics and Statistics (including demand estimation and damages calculations)

SELECTED EXPERIENCE

- For a foreign owner of a gas-fired energy facility, supported expert testimony calculating damages from forced early termination of a gas supply agreement. Evaluated expected economic dispatch over the life of the contract and constructed a cash flow model to predict lost profits.
- For a private antitrust suit, supported plaintiff's expert testimony regarding alleged monopolization claims. Evaluated issues of disparate pricing in two-sided markets and the potential market distortions from price discrimination and exclusive agreements.
- For a foreign competition authority, co-authored a report on the competitiveness of the wireless communications industry (report still under review). Evaluated the structural performance of the market's pricing, concentration, and degree of wireless penetration. Conducted demand estimation and developed a model to simulate effects of de novo entry, including consumer surplus benefits, losses to incumbent carriers, and expected profits and viability of the entrant.
- While at the *Department of Justice*, conducted **merger review** in the following investigations: Exelon/PSEG (energy), Delta/Northwest (airlines), LiveNation/Ticketmaster (entertainment), Mirant/RRI (energy), Allegheny/First Energy (energy), Exelon/Constellation (energy), 3M-Avery (consumer products), Flowers/Hostess Brands (consumer products).
- While at the *Department of Justice*, investigated claims of **monopolization** conduct in the following cases: Google/Yahoo (search and advertising); American Express/Visa/MasterCard (payments), Visa (payments), Entergy (energy), BlueCross/BlueShield of Michigan (health insurance).
- While at the *Department of Justice*, evaluated claims of **price discrimination** and calculated damages and volume of commerce in the following industries and/or cases: municipal bonds, air cargo shipments, and LIBOR manipulation.

ACADEMIC HONORS AND FELLOWSHIPS

University of California Transportation Center Fellowship: Fall 2003 to Spring 2004
School of Social Sciences Predissertation Fellowship: Winter 2003
School of Social Sciences Summer Research Fellowship: Summer 2001, 2002, 2004
Institute for Mathematical Behavior Sciences Summer Fellowship: Summer 2002
Invited Panelist to the Teaching Assistant Professional Development Program, Instructional Resources Center, UC, Irvine: Summer 2003
National Scholar Fellowship: UC, Irvine: Fall 1999 to Spring 2001

OTHER HONORS AND AWARDS

"Award of Distinction" – Antitrust Division, 2010

PUBLICATIONS

A Bayesian Analysis of Tree Structure Specification in Nested Logit Models, Economics Letters (April 2005)

A Comparison of Two Common Approaches for Estimating Marginal Effects in Binary Choice Models, Applied Economics Letters (February 2006)

Do Rockets Rise Faster and Feathers Fall Slower in an Atmosphere of Local Market Power? Evidence from the Retail Gasoline Market, Journal of Industrial Economics (September 2008)

Mimeographs

The Effect of the Internet on Pricing in the Airline Industry (with Leonard Lane) (Available on SSRN)

The Effect of Market Structure on the Empirical Distribution of Airline Fares (Available on SSRN)

Works in Progress

Exact Likelihood Analysis with Interval Regressors

Demand Estimation with Unobserved Product Characteristics for Unchosen Alternatives

Merger Analysis in Nodal-Price Electricity Markets: Residual Demand from Powerflow Models

On the Implications for Geographic Market Definition in Nodal-Price Electricity Markets

Coleman Bazelon
Principal

Washington, D.C. +1.202.955.5050 Coleman.Bazelon@brattle.com

Dr. Coleman Bazelon is a principal in the Washington, DC office of *The Brattle Group*. He is an expert in regulation and strategy in the wireless, wireline, and video sectors. He has consulted and testified on behalf of clients in numerous telecommunications matters, ranging from wireless license auctions, spectrum management, and competition policy, to patent infringement, business valuation, and broadband deployment.

Dr. Bazelon frequently advises regulatory and legislative bodies, including the U.S. Federal Communications Commission and the U.S. Congress. He also has expertise in the federal government's use of discount rates for policy and regulatory analysis, intellectual property valuation, economic impact analysis, and antitrust and damages analysis.

Throughout his career, Dr. Bazelon has had extensive experience with spectrum license auctions. He advises on and evaluates numerous auction designs and regularly serves as an auction advisor for bidders in spectrum license auctions.

Prior to joining *Brattle*, Dr. Bazelon was a vice president with Analysis Group, an economic and strategy consulting firm. During that time, he expanded the firm's telecommunications practice area. He also served as a principal analyst in the Microeconomic and Financial Studies Division of the Congressional Budget Office where he researched reforms of radio spectrum management; estimated the budgetary and private sector impacts of spectrum-related legislative proposals; and advised on auction design and privatization issues for all research at the CBO.

SELECTED CONSULTING PROJECTS

Litigation

- Evaluated damages in the applications market.
- Assessed allocation theories in an international bankruptcy.
- Evaluated damages from a programming contract termination.
- Evaluated damages from allegations of reputational harm.
- Evaluated damages from non-working wireless network equipment.
- Assessed Domestic Industry requirement in ITC 337 case involving wireless equipment patents.
- Assessed commercial viability of full text searching of books business model.
- Assessed Domestic Industry requirement in ITC 337 case involving portable storage device patents.
- Estimated value of satellite assets in bankruptcy.
- Estimated damages from denial of pole attachments.

- Provided written testimony evaluating the performance of a numbering resource administrator.
- Provided written testimony on the ability to estimate damages for a class of satellite phone users.
- Provided written testimony on the economic value of Rights-of-Ways in Massachusetts.
- Estimated damages for a broadcast tower permit revocation.
- Provided oral testimony on the proprietary nature of specific information contained in a statewide public safety network bid.
- Provided written testimony on economic value associated with items provided in a labor neutrality agreement.
- Estimated damages associated with USF and other telephone taxes paid by a calling card reseller.
- Assessed the damages associated with the infringement of patents related to VoIP technology and the likely impact of a permanent injunction.
- Estimated recoverable data costs for two pesticides.
- Estimated cost of delay in granting local cable franchise.
- Analyzed the economic underpinnings of an exclusivity clause of a mobile phone affiliation agreement.
- Assessed commonality issues of physicians for class certification of RICO action against a set of health insurance companies.
- Estimated "Loss of Use" damages for a severed fibre optic cable.
- Provided written testimony estimating the value of a surety bond in a contract dispute involving toll free phone numbers used in an enhanced service application.
- Assessed damages associated with infringement of patents used to provide Voice over Internet Protocol (VoIP).
- Assessed basis for guidance of a large telecommunications firm in a 10-b securities litigation.
- Valued digital television radio spectrum in St. Louis in the pre-litigation phase of a breach of contract dispute.
- Estimated damages in a breach of contract case involving the sale of a fibre optic network.
- Researched the basis for generally optimistic forecasts of broadband deployment in the later 1990s and early 2000s in an anti-trust litigation.
- Researched the basis for generally optimistic beliefs about the telecommunications sector .in the late 1990s in a 10-b securities litigation.
- Assessed the market for Competitive Local Exchange Carriers in an SEC fraud case.
- Assessed a bankruptcy sale proposal for a national tier 1 broadband backbone provider.
- Examined the business case asserted for a small wireless reseller in a breach of contract litigation.
- Assessed damages associated with infringement of patents used in DNA fingerprinting applications.
- Assessed changes in contributions to the Cable Royalty Fund on behalf of Sports Claimants in a Copyright Arbitration Royalty Panel (CARP) proceeding.

- Assessed the capital adequacy of the U.S. branch of a foreign bank.

Regulatory Proceedings

- Provided testimony in prison phone rate proceeding.
- Estimated economic impact of LNP on RLECs.
- Assessed relevance of U.S. UNE-L experience for New Zealand benchmarking proceeding.
- Authored analysis of harm from revoking LightSquared's ATC authorization .
- Estimated value of pairing Upper 700 MHz A Block with public safety.
- Estimated impact of increased regulatory uncertainty on spectrum value.
- Estimated value of government provision of GPS service to private industry.
- Coauthored analysis of feasibility of reallocating broadcast television through the use of incentive auctions.
- Analyzed impact on spectrum value of pairing AWS III spectrum.
- Coauthored analysis of the merits of licensed versus unlicensed allocation of the TV White Spaces.
- Estimated the value of TV White Spaces.
- Provided written testimony on the economic harm of using proprietary information in retention marketing.
- Provided written testimony on the economics of pole attachment rates.
- Estimated the value of the PCS H-Block spectrum band.
- Estimated the economic impact of ITC Exclusion Order on cell phone handsets.
- Authored several reports on the 700 MHz auction rules.
- Analyzed the relationship between the size of cable systems and the economics of the programming market.
- Presented analysis on pricing differentials in overlapping cable markets.
- Assessed proposed regulation of mobile phone roaming rates.
- Analyzed impact of local franchise requirements on competition in the video marketplace.
- Developed and assessed Indian spectrum management proposals.
- Analyzed economic ramifications of à la carte cable channel pricing on consumers and the cable and television programming industries.
- Examined the relative merits of licensed versus unlicensed radio spectrum and the effects of "underlay" licenses on existing commercial licensees.
- Examined federalism issues related to mobile telephony regulation.
- Examined and refuted arguments suggesting that the California Telecommunications Consumer Bill of Rights was an appropriate response to market failures.
- Assessed the impact on consumers of California's Telecommunications Consumer Bill of Rights proposal.

- Provided written testimony refuting analysis purporting to show a positive relationship between UNE-P and telecom network investment.
- Provided written testimony examining the effects of unbundling regulations on capital spending in the telecommunications sector.
- Estimated the adjustment to the TELRIC pricing formula to account for irreversible investment in the local telephone network.
- Examined the impact of irreversible investments in the local telephone network on the TELRIC pricing methodology.
- Assessed the degree of market overlap of two food service firms for purposes of merger review.
- Provided written testimony that assessed the validity of an analysis of the costs of a DTV tuner mandate.
- Provided written testimony of a forecast of toll free number demand for the toll free number administrator, SMS/800, in a rate case proceeding.

Other

- Advised bidder in Canadian 700 MHz auction.
- Evaluated performance of TV stations when repacked in an Incentive Auction.
- Analyzed differences in U.S. and European wireless markets.
- Assessed business case and value of HF license holder.
- Analyzed likely auction outcomes for TV broadcaster participating in incentive auction.
- Assessed value of commercial mobile spectrum bands.
- Analyzed economic impacts of the commercial casino industry.
- Evaluated impact of digitization on copyright industries.
- Analyzed economic and employment effects of Dutch gas hub.
- Advised bidder in Indian 3G spectrum license auction.
- Estimated economic and employment effects of network neutrality regulation.
- Analyzed relative costs of wireless and wireline deployments in rural areas.
- Analyzed potential harms from Internet gambling.
- Estimated economic value of reallocating TV spectrum for wireless broadband.
- Estimated economic and employment effects of electric power transmission construction in support of new wind generation facilities.
- Estimated economic and employment effects of broadband stimulus grant applications.
- Estimated employment effects of an ATC-mobile satellite network deployment.
- Analyzed the impact of reducing international mobile phone roaming charges.
- Developed an auction platform for an electricity procurement auction.
- Analyzed the economic impacts of reduced mobile phone taxes in Africa and the Middle East.
- Evaluated the impact of reducing ethanol requirements on gasoline prices.
- Analyzed FRAND licensing requirements for intellectual property in the DTV standard.
- Advised bidder in Canadian AWS spectrum license auction.
- Advised bidder in FCC 700 MHz spectrum license auction.

- Evaluated a business plan for proposed dam removals.
- Assessed a business plan involving the WiMAX market.
- Estimated the value of a portfolio of spectrum licenses.
- Assessed the budgetary impacts of legislation to license TV white spaces.
- Analyzed the economics of the military's build versus buy decision for broadband satellite communications capacity.
- Advised bidder in FCC AWS spectrum license auction.
- Provided framework to estimate impact of the effect of designation of TV white spaces as unlicensed on 700 MHz auction receipts.
- Analyzed Universal Service Fund expenditures.
- Analyzed cable franchising requirements.
- Valued proposals to re-band the Upper 700 MHz Band of radio spectrum.
- Analyzed proposed accelerated digital television transition impacts on society and the federal budget.
- Coauthored a report on the value of a portfolio of patents used to provide Voice over Internet Protocol (VoIP).
- Coauthored a report to the U.S. Chamber of Commerce on the economic effects of telecommunications deregulation.
- Assessed the business cases for IRU swaps of a large international fibre optic network owner.
- Examined the effects of unbundling regulations on broadband penetration internationally.

TESTIMONY AND DECLARATIONS

"Rebuttal Expert Report of Coleman Bazelon, Ph.D.," In the Matter of the Companies' Creditors Arrangement Act, R.S.C. 1985, c. C-36, As Amended, and in the Matter of a Plan of Compromise or Arrangement of Nortel Networks Corporation, Nortel Networks Limited, Nortel Networks Global Corporation, Nortel Networks International Corporation and Nortel Networks Technology Corporation United States Bankruptcy Court for the District of Delaware, Case No. 09-10138 (KG), February 28, 2014.

"Supplemental Expert Report of Coleman Bazelon, Ph.D.," In the Matter of Sky Angel U.S., LLC, against Discovery Communications, LLC, Animal Planet, LLC, United States District Court for the District of Maryland, Case No. 8:13-cv-00031-DKC, January 31, 2014.

"Expert Report of Coleman Bazelon, Ph.D.," In the Matter of the Companies' Creditors Arrangement Act, R.S.C. 1985, c. C-36, As Amended, and in the Matter of a Plan of Compromise or Arrangement of Nortel Networks Corporation, Nortel Networks Limited, Nortel Networks Global Corporation, Nortel Networks International Corporation and Nortel Networks Technology Corporation United States Bankruptcy Court for the District of Delaware, Case No. 09-10138 (KG), January 24, 2014.

"Expert Report of Coleman Bazelon, Ph.D.," In the Matter of Sky Angel U.S., LLC, against Discovery Communications, LLC, Animal Planet, LLC, United States District Court for the District of Maryland, Case No. 8:13-cv-00031-DKC, December 6, 2013.

"Expert Report of Coleman Bazelon, Ph.D. and Armando Levy, Ph.D," In the Matter of LT Game International Ltd., against Shuffle Master, Inc., United States District Court for the District of Nevada, Case No. 2:12-cv-01216-JAD-GWF, October 4, 2013.

"Expert Report of Coleman Bazelon, Ph.D.," In the Matter of Certain Electronic Devices, Including Wireless Communications Devices, Tablet Computers, Media Players, and Televisions, and Components Thereof, United States International Trade Commission, Investigation No. 337-TA-862 (Judge Shaw), July 5, 2013.

"Declaration of Coleman Bazelon" In the Matter of PTA-FLA, Inc, Daredevil, Inc., NTCH-WEST TENN., Inc., NTCH-WA, Inc., and Eric Steinmann against ZTE Corporation, and ZTE USA, Inc. Florida Arbitration, Case No.: 50-494-T-00665-11, February 26, 2013.

"Rebuttal Testimony of Coleman Bazelon," In re: Petition for Suspension or Modification of Application of the Requirements of 47 U.S.C. § 251(b) and (c), pursuant to 47 U.S.C. § 251(f)(2) regarding Time Warner Cable Information Services (Maine) LLC's Request, State of Maine Public Utilities Commission, Docket No. 2012-198, Docket No. 2012-218, Docket No. 2012-219, Docket No. 2012-220, Docket No. 2012-221, October 12, 2012.

"Testimony of Coleman Bazelon, Ph.D.," In re: Petition for Suspension or Modification of Application of the Requirements of 47 U.S.C. § 251(b) and (c), pursuant to 47 U.S.C. § 251(f)(2) regarding Time Warner Cable Information Services (Maine) LLC's Request, State of Maine Public Utilities Commission, Docket No. 2012-198, Docket No. 2012-218, Docket No. 2012-219, Docket No. 2012-220, Docket No. 2012-221, August 20, 2012.

"Expert Report of Dr. Coleman Bazelon," *Salsgiver Communications, Inc., Salsgiver Telecom, Inc., and Salsgiver Inc. v. Consolidated Communications Holdings, Inc., North Pittsburgh Systems, Inc., and North Pittsburgh Telephone Company, Inc.,* Court of Common Pleas, Allegheny County, Pennsylvania, Civil Division, No. GD 08-7616, May 10, 2012.

"Oral Testimony of Coleman Bazelon, The Brattle Group, Inc. before the U.S. House of Representatives, Committee on Energy and Commerce Subcommittee on Communication and Technology," April 12, 2011. (spectrum)

"Testimony of Coleman Bazelon, Principal, *The Brattle Group*, before the U.S. House of Representatives, Committee on Energy and Commerce, Subcommittee on Communications, Technology, and the Internet," June 17, 2010 (spectrum valuation).

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"Prefiled Direct Testimony of Coleman D. Bazelon," In re: Complaint and Request for Emergency Relief Against Verizon Florida LLC for anticompetitive behavior in violation of Sections 364.01(4), 364.3381, and 364.10, F.S., and for failure to facilitate transfer of customers' numbers to Bright House Networks Information Services (Florida) LLC, and its affiliate, Bright House Networks, LLC, Florida Public Service Commission, Docket No. 070691-TP, May 30, 2008.

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"Testimony of Coleman Bazelon, Principal, *The Brattle Group*, before the U.S. House of Representatives, Committee on Energy and Commerce, Subcommittee on Telecommunications and the Internet," April 15, 2008 (reviewing the 700 MHz auction).

"Concerning the Meaning of 'Fair and Reasonable Compensation' in Section 253(c) of the Telecommunications Act of 1996 and the Comparability of the Rights-of-Way Fees Paid by Level 3 in Massachusetts and Elsewhere," *The Massachusetts Turnpike Authority v. Level 3 Communications, LLC, et al.,* The United States District Court for the District of Massachusetts, Civ. Act. No. 06-11816, December 17, 2007.

"Concerning the Effects of the Fixed Rent Charged for Access to the Massachusetts Turnpike," *The Massachusetts Turnpike Authority v. Level 3 Communications, LLC, et al.,* The United States District Court for the District of Massachusetts, Civ. Act. No. 06-11816, November 12, 2007.

"Affidavit of Dr. Coleman Bazelon," *Gulfside Casino Partnership v. Mississippi Riverboat Council, et al.*, United States District Court for the Southern District of Mississippi, Southern Division, Cause No. 1:07-CV-110-LG-JMR, May 4, 2007.

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"Affidavit of Dr. Coleman Bazelon," *Informed Communications Systems, Inc. v. Intelogistics Corp., d/b/a Prosodie Interactive*, United States District Court, Southern District of Florida, Miami Division, Case No.: 04-61245 CIV Huck/Turnoff (October 12, 2004).

EXPERT DESIGNATIONS

- *Touch America, Inc. v. Qwest Communications International, Inc.*
    - Designated as an expert in Arbitration (June 2003)
- *Informed Communications Systems, Inc. v. Intelogistics Corp., d/b/a Prosodie Interactive*, United States District Court, Southern District of Florida, Miami Division, Case No.: 04-61245 CIV Huck/Turnoff
    - Filed affidavit (October 12, 2004)
- *Level 3 Communications, LLC v. City of St. Louis, Missouri*, United States District Court for the Eastern District of Missouri, Eastern Division, Consolidated Case No. 4:04-CV-871 CAS
    - Filed Rebuttal Report (June 17, 2005)
    - Deposition (July 14, 2005)
- Cable Merger before the FTC

  - Presented analysis to FTC staff (March 20, 2007)

- *Gulfside Casino Partnership v. Mississippi Riverboat Council, et al.*, United States District Court for the Southern District of Mississippi, Southern Division, Cause No. 1:07-CV-110-LG-JMR
  - Filed affidavit (May 4, 2007)
- *Motorola, Inc. v. State of Mississippi Department of Information Technology Services and M/ACom, Inc.*, Chancery Court of Hinds County, Mississippi, Cause No. G2006-2179 S/2
  - Testified (May 23, 2007)
- *American Towers, Inc. v. Jackson & Campbell, P.C., et al.*, DC Superior Court, No. 003277-06
  - Deposition (March 19, 2009)
  - Filed Affidavit (May 22, 2009)
- *The Massachusetts Turnpike Authority v. Level 3 Communications, LLC, et al.,* The United States District Court for the District of Massachusetts, Civ. Act. No. 06-11816
  - Filed Expert Report (November 12, 2007)
  - Filed Rebuttal Report (December 17, 2007)
  - Deposition (January 21, 2008)
- *Kenneth Stickrath, et al v. Globalstar, Inc.,* United States District Court for the Northern District of California, San Francisco Division, Case No. 07-CV-01941 THE
  - Filed Declaration (April 25, 2008)
  - Deposition (June 11, 2008)
- In re: Complaint and request for emergency relief against Verizon Florida LLC for anticompetitive behavior in violation of Sections 364.01(4), 364.3381, and 364.10, F.S., and for failure to facilitate transfer of customers' numbers to Bright House Networks Information Services (Florida) LLC, and its affiliate, Bright House Networks, LLC, Florida Public Service Commission, Docket No. 070691-TP
  - Filed Direct Testimony (May 30, 2008)
  - Filed Rebuttal Testimony (July 25, 2008)
  - Deposition (August 13, 2008)
- *Gemalto PTE LTD and Gemplus S.A. v. Telecommunications Industry Association,* United States District Court for the Eastern District of Virginia, Alexandria Division, Case 1:08-cv-00776- LMB-TRJ
  - Filed Expert Report (November 6, 2008)
  - Deposition (December 2, 2008)

  - Filed Supplemental Expert Report (December 16, 2008)

- *Salsgiver Communications, Inc., Salsgiver Telecom, Inc., and Salsgiver Inc. v. Consolidated Communications Holdings, Inc., North Pittsburgh Systems, Inc., and North Pittsburgh Telephone Company, Inc.*, Court of Common Pleas, Allegheny County, Pennsylvania, Civil Division, No. GD 08-7616
  - Filed Damages Analysis (February 27, 2009)
  - Deposition (April 3, 2012)
  - Filed Expert Report (May 10, 2012)
- *Certain Products Containing Interactive Program Guide and Parental Control Technology* United States International Trade Commission, Investigation No. 337-TA-820
  - Designated as an expert (June 8, 2012)
- In re: Petition for Suspension or Modification of Application of the Requirements of 47 U.S.C. § 251(b) and (c), pursuant to 47 U.S.C. § 251(f)(2) regarding Time Warner Cable Information Services (Maine) LLC's Request, State of Maine Public Utilities Commission, Docket No. 2012-198, Docket No. 2012-218, Docket No. 2012-219, Docket No. 2012-220, Docket No. 2012-221
  - Filed Direct Testimony (August 20, 2012)
  - Filed Rebuttal Testimony (October 12, 2012)
  - Testified (October 23, 2012)
- In the matter of PTA-FLA, Inc , Daredevil, Inc., NTCH-WEST TENN., Inc., NTCH-WA, Inc., and Eric Steinmann against ZTE Corporation, and ZTE USA, Inc. Florida Arbitration, Case No.: 50-494-T-00665-11
  - Filed Expert Report (February 26, 2013)
  - Deposed (March 15, 2013)
  - Testified (August 30, 2013)
- *Certain Electronic Devices, Including Wireless Communications Devices, Tablet Computers, Media Players, and Televisions, and Components Thereof*, United States International Trade Commission, Investigation No. 337-TA-862 (Judge Shaw)
  - Filed Rebuttal Testimony (July 5, 2013)
- In the matter of LT Game International Ltd., against Shuffle Master, Inc., United States District Court for the District of Nevada, Case No. 2:12-cv-01216-JAD-GWF
  - Filed Expert Report (October 4, 2013)

- In the Matter of Sky Angel U.S., LLC, against Discovery Communications, LLC, Animal Planet, LLC, United States District Court for the District of Maryland, Case No. 8:13-cv-00031-DKC
    - Filed Expert Report (December 6, 2013)
    - Filed Supplemental Report (January 31, 2014)
    - Deposed (February 14, 2014)
- In the Matter of the Companies' Creditors Arrangement Act, R.S.C. 1985, c. C-36, As Amended, and in the Matter of a Plan of Compromise or Arrangement of Nortel Networks Corporation, Nortel Networks Limited, Nortel Networks Global Corporation, Nortel Networks International Corporation and Nortel Networks Technology Corporation United States Bankruptcy Court for the District of Delaware, Case No. 09-10138 (KG)
    - Filed Expert Report (January 24, 2014)
    - Filed Rebuttal Expert Report (February 28, 2014)
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"Next Generation Frequency Coordinator," *Telecommunications Policy* 27 (2003), pp. 517-525.

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Coleman Bazelon and Giulia McHenry, "Violating Your Privacy: An Economic Perspective," Telecommunications Policy Research Conference, September 24, 2013.

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"Cost of Regulatory Risk for Wireless Spectrum Values," sponsored by LightSquared, August 23, 2011.

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"Comments of Charles L. Jackson, Dorothy Robyn and Coleman Bazelon," Comments, WC Docket No. 06-150, PS Docket No. 06-229, June 20, 2008 (value of TV White Spaces).

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Thomas W. Hazlett, Coleman Bazelon and Arthur Havenner, "Forecast of Toll Free Number Demand: 2002-2004," Attachment A, SMS/800 Transmittal No. 22, F.C.C. Tariff No. 1, November 15, 2002.

"Comments of Coleman D. Bazelon and T. Christopher Borek Relating to Arthur D. Little, Inc.'s Assessment of the Impact of DTV on the Cost of Consumer Television Receivers," *Ex Parte* Comments MM Docket 00-39, August 1, 2002.

"Use Administrative Law Judges to Adjudicate Interference Disputes Between Licensees," Comment, ET Docket No. 02-135, July 8, 2002.

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Bloomberg BNA Webinar: "S*pectrum Auctions Are Back: What you need to know",* February 19, 2014.

Violating Your Privacy: An Economic Perspective, 41st Annual Telecommunications Policy Research Conference (TPRC), Arlington, VA, September 28, 2013.

Other Recent and Planned Spectrum Auctions: What They Portend for the Future: Economic Perspectives on the Auctions, Law Seminars International, Washington, D.C., July 22, 2013.

Spectrum Auction Policy: Potential Outcomes for Economic Growth and Public Safety, Georgetown University McDonough School of Business, Rayburn House Office Building, Washington, D.C., May 14, 2013.

Markets in Wireless Spectrum, Towards Dynamic Markets in Electric Power, Water, and Wireless Spectrum Seminar, University of Colorado Law School, Boulder, CO, April 23, 2013.

Annual College of Social Studies Spring Banquet/ the Underwood Memorial Lecture and Hoggendorn lecture for the Economic Department, Wesleyan University, Middletown, CT, April 17 – 18, 2013.

SNL Knowledge Center Webinar: "*FCC Incentive Auction Rules: Estimating Clearing Prices and Policy Impacts*", February 27, 2013.

Reverse Auction Design: Dynamic or Sealed, Algorithmic Issues, Market Power, Reserves, Reference Prices, Conference on the FCC Incentive Auction, Stanford Institute for Economic Policy Research, Stanford, CA, February 26, 2013.

Mobile Impact on Economic Growth and Job Creation, Consumer Electronics Show, LIT Program Innovation Policy Summit, Las Vegas, NV, January 8, 2013.

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Incentive Auctions, 39th Annual Telecommunications Policy Research Conference (TPRC), Arlington, VA, September 24, 2011.

Competition in the Wireless Environment: How to Get More Handsets or More Networks, Broadband Breakfast Club, Washington, DC, February 15, 2011.

Introducing TV White Spaces, Spectrum Bridge webinar, October 28, 2010.

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How Smart Public Policies Can Drive the Mobile Broadband Transformation, Information Technology and Innovation Foundation's The Emerging Mobile Broadband Economy and its New Business Models, Washington, DC, September 14, 2010.

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Unraveling Net Neutrality: Should the FCC Regulate Broadband, Independence Institute, Denver, CO, May 26, 2010.

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Keynote Address, Enterprise Wireless08, Scottsdale, AZ, November 6, 2008.

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Sending the Right Signals: Promoting Competition Through Telecommunications Reform: A Report to the U.S. Chamber of Commerce, presentation of report to the US Chamber of Commerce, October 6, 2004.

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Completing the Transition to Digital Television, Telecommunications Policy Research Conference, Arlington, VA, September 1999.

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REVIEWER

- American Journal of Agricultural Economics (1989 – 1994)
- Congressional Budget Office Reports

- Telecommunications Policy
- Telecommunications Policy Research Conference Program Committee (2011-2013)
- George Mason University

PROFESSIONAL AFFILIATIONS

- American Bar Association
- American Economic Association
- Federal Communications Bar Association
- National Research Council - Committee on a Survey of the Active Scientific Use of the Radio Spectrum

EDUCATION

Dr. Bazelon received his Ph.D. and M.S. in Agricultural and Resource Economics from the University of California at Berkeley. He also holds a Diploma in Economics from the London School of Economics and Political Science and a B.A. from Wesleyan University.

March 31, 2014

CAMBRIDGE
NEW YORK
SAN FRANCISCO
WASHINGTON
LONDON
MADRID
ROME

THE Brattle GROUP