Comparing Digital Divides: Internet Access and Social Inequality in Canada and the United States

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ABSTRACT *What is the best way to measure and track the digital divide, in a comparative manner, over time? What impact have differing policy interventions had on the digital divide in Canada and the United States? We offer a way of benchmarking equality in Internet access using Gini coefficients and demonstrate that overall the digital divide has been closing in both countries. We find that in terms of income, the digital divide in Canada has closed most dramatically, and that in terms of education, the digital divide remains most pronounced in the United States. We suggest that Canada has been more successful in reducing the concentration of Internet access among wealthy educated populations, in part due to the active role of the state in supporting the production of culturally relevant digital content.*

KEYWORDS *Digital divide; Technology diffusion; Telecommunications policy; Canada; United States; Comparative methods; Gini coefficients*

RÉSUMÉ *Cette étude compare les représentations aux nouvelles des agences autochtones de bien-être de l'enfant avec celles d'autorités provinciales telles que le Ministry of Children and Family Development en Colombie-Britannique. La couverture médiatique d'incidents critiques impliquant des enfants sous la tutelle d'agences provinciales met généralement l'accent sur des problèmes systémiques tels que les coupures dans les programmes, le manque de ressources et les déficiences organisationnelles – des conditions sur lesquelles le travailleur social a peu de contrôle. En contraste, ces facteurs contextuels sont généralement absents des reportages sur les agences autochtones. La plupart des reportages et chroniques jettent plutôt le blâme sur le travailleur social et l'administrateur autochtones tout en mettant en question les compétences de l'intervenant autochtone en général. En revanche, les chroniques écrites par des autochtones soulèvent des questions structurelles et des facteurs contextuels qui sont absents des autres reportages.*

MOTS CLÉS *Fracture numérique; Diffusion de la technologie; Canada; États-Unis; Politique en télécommunications; Méthodes comparatives; Coefficients de concentration*

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In today's competitive, global economy, access to information and communication technologies (ICTs) is a key advantage. Canada and the U.S., however, have pursued different strategies for improving public access to the Internet. Whereas governments in both countries have invested in digital communications infrastructure and encouraged public-sector investment by deregulating the markets for telecommunications services, Canada has targeted investments in schools, libraries, and forms of cultural content production. Is the digital divide narrowing in Canada and in the U.S. and, if so, in which domains of social inequality? What is the best way of measuring inequality in the distribution of Internet access and then comparing these inequalities across countries?

The digital divide is traditionally thought of as describing the difference in the kinds of information and communication technologies to which people have access (Norris, 2001). Worldwide, there is a modest correlation between economic wealth, information access, and a democratic political environment. However, it has been difficult to relate policy interventions with improvement in the diffusion or distribution of information technology within or between countries (Howard, Busch, Nafus, & Anderson, 2009; Howard & Mazaheri, 2009). And while some researchers have worked on the international digital divide by developing quantitative measures, much less work has been done on developing benchmarks for measuring the digital divide within countries.

There is no straightforward connection between new-liberal policy reforms in the telecommunications sector and closing the digital divide (Howard & Mazaheri, 2009). In the mid-1990s, most of the Internet's computer nodes were physically based in the United States and a handful of other wealthy nations, and most Internet users were at universities, in government and military agencies, or living in urban areas and paying for dial-up services (Davison & Cotton, 2003). By the late 1990s, new information and communication technologies were diffusing rapidly, but unevenly, around the world. New users in most countries belonged to specific categories of race and class and were more often male, well educated, and younger, and this had implications for the kinds of civic engagement and social interaction found online (Howard, 2004; Kling, 1996). The benefits of fast, multimedia networks in today's communication-intensive world economy are accruing disproportionately to those who can afford access or who work in institutions that provide access (Badshah, Garrido, & Khan, 2005; Mossberger, Tolbert, & Stansbury, 2003).

Not only does Internet use allow people to maintain distant social networks, but studies of Toronto and Boston reveal that friends and family raise the intensity of their interaction within social networks (Hampton, 2007; Hampton & Gupta, 2008). There is some evidence that wireless Internet access does not simply add a new layer of communication to public spaces, but increases social interaction within those spaces. Community-based wireless infrastructure projects are, on their own, new forms of non-governmental, non-market organization (Middleton & Crow, 2008).

Unfortunately, most efforts to create indices to chart the development of information societies are focused on perception indices of attributes such as "network readiness." Such studies emphasize the growing raw number of Internet users around the world and the diminishing costs of digital technologies for both governments and indi-

vidual consumers (Dutta & Lopez-Claros, 2005; World Economic Forum, 2002). These statistics provide little insight into the cultural patterns of technology adoption—and adaptation—and the skewed distribution of information access (Persaud, 2001; Press, 2005). Our aim is to identify and understand the aspects of American and Canadian telecommunications policy that may have exacerbated or mitigated the digital divide—defined as inequality in access to information and communication technology resources.

The causes and consequences of the digital divide have become a contested area of research. Understanding the digital divide is crucial to understanding the role of the Internet in contemporary social development. In the early 1990s, the digital divide was clearly technical: international connections to the Internet were made through slow dial-up services, few countries had their own domain names, and few countries had the capacity to manufacture, much less maintain, computer technologies (Howard, 2010). Much of today's research assumes that the digital divide is best revealed by measuring Internet use per capita. While a difference in the proportion of Internet users in two countries may indicate a digital divide, a change in the digital divide occurs only if the proportions change over time.

There is an important difference between observing a wide digital divide and observing a widening digital divide (Firebaugh, 1999). Moreover, measuring national rates of technology diffusion with a simple ratio of Internet users per capita will not reveal how such technologies may be diffusing unevenly by socioeconomic status. If the overall number of computers in the country grows, but particular social segments continue to get a major—but constant—proportion of those computers, then there has been no change in the relative distribution of computers among the population. In other words, if the rate of change is constant—for example, if individuals in Canada use the Internet at the same rate as those in the United States—then the digital divide between countries is not really growing. Moreover, if rates of Internet use are consistent across groups of people in different parts of these two countries, and across different levels of education or income, then the digital divide within the countries is not increasing. There is significant qualitative and country-specific evidence that Internet use may be concentrated in urban areas and wealthy households, so a more useful metric would make it possible to compare technology diffusion across categories of social inequality and between countries.

Both Canada and the U.S. were among the first governments to privatize their national telecommunications provider, and both opened up their retail communications markets to multiple service providers in 1988. While the U.S. eliminated political influence over the telecommunications regulator in 1980, Canada only did this in 1992, and by 2000 the U.S. regulator was again a highly politicized body. Moreover, on a per capita basis, Canadian federal, provincial, and municipal governments spend significantly more on Internet access in schools, libraries, and community centres than is spent in the U.S. On the other hand, competition in U.S. telecommunications markets is particularly fierce. Over the last decade, has the digital divide really closed in Canada and the U.S.? What combination of policy environments and market-led diffusion does the most to improve equity in Internet access?

This article has three components. First, we review the existing literature on Internet adoption and telecommunications policy interventions in Canada and the United States, with particular attention to research that either takes a comparative perspective or reveals contrasting trends. Second, we offer a new conceptual way of measuring the distribution of Internet access within each country, on the basis of relevant categories of social inequality suggested in the literature. Finally, we compute these measurements and use them to help evaluate the impact of each country's policy interventions on long-term outcomes: change in the digital divide by political geography, family income, and education.

Causes and consequences of the digital divide in Canada

Since the early 1990s, the Canadian government has developed policies to promote a smooth transition to an information society and to provide some form of Internet access to all Canadians. Yet Canada's geography, history, and culture have created digital divides: gaps in access, technical knowledge, and content between urban and rural communities, indigenous and non-indigenous Canadians, high- and low-income families, Francophones and Anglophones, and the young and old. Since the Internet has been recognized as an important medium for disseminating information about culture and politics, the Canadian government has sought to close these gaps through policies promoting the development of infrastructure, digital literacy, and Web content (Elmer, Ryan, Devereaux, Langlois, Redden, & McKelvey, 2007; Jansen & Koop, 2005; Sedo, 2008).

The development of infrastructure is of great importance for reducing the digital divide affecting rural or remote communities, including remote indigenous communities (particularly in Canada's far North and East). With little access to cable lines and few local Internet service providers (ISPs) serving rural and remote regions, the cost of developing infrastructure is high. This has led to the creation of federal government incentives to promote private-sector investment in ICT infrastructures and technical training. Furthermore, once infrastructures are in place and the population is digitally literate, it is essential to create content relevant to these rural and remote communities in order to close the gap between urban and rural Internet use (Crompton, 2004).

The digital divide that affects the urban poor, the elderly, and the poorly educated is also due to limited Internet access and digital illiteracy. Those with higher education and higher incomes are more likely to own computers, allowing more time to develop technical skills. In a Canadian study on student Internet access, those with home computers were more likely to have developed technical literacy than those who went online at their school or library (Looker & Thiessen, 2003). Thus, there is a divide between families that can afford Internet access and can access it in their own home (and can develop the technical skills necessary to productively use the Internet) and those who cannot.

While the causes of the Canadian digital divide primarily rest upon a lack of Internet access and digital literacy, digital divides can also occur when there is a lack of culturally relevant content. In *The Dual Digital Divide*, Reddick, Boucher, and Groseilliers (2000) identify "near users" as people who are interested in using the

Internet, but who are unable to afford or find easy access. They include individuals in remote communities and low-income families. Conceptually, it makes sense to distinguish between the reasons for non-use, which can range from access and affordability to interest (Selwyn, 2004). In the late 1990s, a larger proportion of Francophones were not using the Internet because of both the high costs and the paucity of culturally relevant online content (Reddick et al., 2000). While French and English are Canada's two official languages, the lack of content in French and about French Canadian communities diminished the incentive for Internet use. The Canadian Internet Use Survey reports that while roughly 21% of Canadians have French as a mother tongue, only 9% use French to search for information online (Statistics Canada, 2005). Other non-users who have access to the Internet are often over the age of 55, do not feel the Internet is useful, are uninterested in the content online, or lack the technical skills to use the Internet (Reddick et al., 2000).

There is significant evidence of a gender gap in Internet access, especially in terms of technical means, social support, skills, autonomy of use, and forms of online activity such as civic engagement. While there are public policy and education initiatives to encourage technology use by women—particularly at the high school level—there are few Internet access programs targeted specifically at women (Boulianne, 2003; Crow & Shade, 2005; Shade, 2004). This type of digital inequality has also been found within Canadian schools. Looker & Thiessen (2003) conclude that within high schools, gender, rural–urban location, and parental education all have an impact on patterns of use and attitudes to new technologies. Although some of the differences are not large, the authors conclude that "they seem to be persistent and are likely to affect the ways and the extent to which members of different subgroups involve themselves in the information society" (p. 487).

Described as avid technological determinists, Canadian policymakers are said to view Internet use as the solution to Canada's ongoing social, cultural, and economic problems (Alexander, 2001; Middleton & Sorensen, 2005). From this perspective, a lack of infrastructure, relevant cultural content, and technical knowledge has very serious repercussions for Canadians. Those who lack Internet access and sophisticated search skills miss out on job opportunities in the burgeoning telecommunications sector (and other sectors dependent on information technology for commerce), less access to government information portals, and limited access to new health care developments (such as telemedicine) and e-learning opportunities (Industry Canada, 1996; Lie, 2003; Middleton & Sorensen, 2005; Mossberger, 2009; National Broadband Task Force, 2001). These digital divides can also lead to disparities in civic engagement: Internet access has been shown to support a significant amount of non-voting political activity in Canada and the United States (Howard, 2005, 2006; Keown, 2007). Moreover, the Canadian government is concerned that those who do not use the Internet may remain on the periphery of ongoing online cultural and social developments: they would not be able to take part in Canadian national identity and cultural developments online (Canada, 2005; Rideout, 2000, 2002).

Since the Canadian government has recognized the Internet as an important medium for disseminating information, culture and politics (Elmer et al., 2007; Jansen

& Koop, 2005; Sedo, 2008) and an important tool for developing Canada's economy, national identity, and culture, the government has developed a range of policies to promote Internet accessibility, education, and content development. These policies have focused on closing the digital divide through the development of infrastructure in remote or rural areas, the online promotion of Canadian culture and national identity, and the development of access to technology in the education and health sectors (Canada, 1993; Canada, 2005; Industry Canada, 1994, 1996, 2003, 2004, 2005b; National Broadband Task Force, 2001). These policy frameworks, with a strong focus on e-business and e-learning initiatives, built a telecommunications strategy that was "made in Canada, by Canadians, for Canadians" (Industry Canada, 1994), though observers have noted that many of the concerns of public-interest groups were not reflected in government policy papers during the 1990s (McDowell, 1993; McDowell & Buchwald, 1997). Canadian policy, from the 1993 *Telecommunications Act* up through the 2006 final report of the Telecommunications Policy Review Panel, focused on building a telecommunications strategy that promoted government regulation combined with a reliance on Canadian market forces.

Connecting rural and remote communities, including indigenous communities, has been an important focus of Canadian telecommunications policy and government pilot programs. Attempting to make Canada the most connected OECD country by 2004, the federal government used policy regulations and incentives to fill the gaps where communications markets would not alone provide services, particularly in rural areas where the high cost of developing new infrastructure was being passed directly on to consumers or was discouraging ISPs from offering services at all (Industry Canada, 1994, 1996; National Broadband Task Force, 2001). In 1996, Industry Canada and Human Resources Development Canada proposed the Community Access Program (CAP), a part of the Community Learning Network initiative, which intended to establish access for 1,500 rural communities by 1998 (Industry Canada, 1996). In 2001, the National Broadband Task Force was established to propose broadband strategies to connect rural and indigenous Canadians by the 2004 deadline (National Broadband Task Force, 2001). In September 2002, the government created the pilot program Broadband for Rural and Northern Development (BRAND) based upon a community aggregator model (Lie, 2003). This five-year initiative was intended to bring broadband to remote and rural areas.

To better connect Canada's First Nations populations, the government concluded that indigenous communities needed better, locally produced cultural content, education in technical literacy, and accessible and affordable broadband services (Alexander, 2001). Two programs, Gathering Strength and Connecting Canadians, have attempted to connect rural and indigenous populations by providing broadband to community access points such as local schools and libraries (Alexander, 2001), as well as setting aside funds for creating Aboriginal-based content, such as the Aboriginal Digital Collections project (Lie, 2003) and the Aboriginal Canada Portal (Alexander, 2001). Much like those created to address the rural–urban digital divide, the policies to connect First Nations peoples to the larger Canadian community have followed strategies of establishing publicly accessible Internet access points in the

community, making the Internet affordable through government regulation and subsidies, and supporting community-authored content for the local population.

Two policy programs have been at the forefront of bridging the digital divide between Francophones and Anglophones. The 1998 pilot program, Francommunautés Virtuelles, created and promoted websites with French content and funded the development of French-language Web applications (Industry Canada, 2005a). In 2002, the government report, "Official Language Requirements and Government On-Line," affirmed the continuing need for bilingual online government resources in terms of both language rights and effective public service (Canada, 2005).

While Canada has pursued its policy objective of connecting all Canadians, it was unable to reach the 2004 goal, and observers argue that the divide between rural and urban, indigenous and non-indigenous, rich and poor, and young and old remains. Industry Canada's 2006 Telecommunications Policy Review Panel found that despite the government's best efforts, access, affordability, content, and technical literacy were still at the heart of the digital divide. Finding fault in government regulation of private market forces and the use of multiple pilot programs that did not always target the most cost-efficient applications for infrastructure funding, the review panel suggested changes to the 1993 *Telecommunications Act* to loosen government regulation and depend more on market forces by encouraging foreign investment (Industry Canada, 2006). The panel suggested the creation of the Ubiquitous Canadian Access Network (U-CAN) program as a permanent solution to the problems of the BRAND pilot program, to identify areas where market forces would be unsuccessful in order to ensure that only *those* areas would be provided with government funding (Industry Canada, 2006). The panel's recommendations of limiting government regulation and appealing to foreign investment will surely be controversial as Canada's government moves from a policy that focuses on telecommunications "made in Canada, by Canadians, for Canadians" to a policy to be determined by market forces (Industry Canada, 1994).

The causes and consequences of the digital divide in the United States

Hawkins (2005) identifies several major themes that have characterized much digital divide research in the United States, beginning with the conceptual definition offered by the seminal reports of the National Telecommunications and Information Administration (NTIA) on the distribution of Internet technology and use in the U.S. (Hawkins, 2005). These reports distinguish between the causes and consequences of the digital divide: lack of physical access to technology and infrastructure, for example, by virtue of income, education, or geographical location, causes digital divides; those who are not connected, as a consequence, miss out on economic benefits. Hawkins traces these themes through digital divide research, finding that they have dictated much of the subsequent scholarship, and even policy, on the digital divide in the United States.

Throughout most U.S. policy, and in much scholarship on the topic, access has been considered mostly in physical terms and as a problem for markets to tackle (Stewart, Gil-Egui, Tian, & Pileggi, 2006). Populations in rural areas, for example, have less opportunity to access the Internet (Hawkins, 2005). The mechanism seems to be

an economic one: because rural areas are poorer, it is less profitable for Internet service providers (ISPs) to extend their technology to these communities—not only is it more expensive to set up the infrastructure in a remote area, but there is little assurance consumers in these areas will be able to afford service (Rowe, 2003). In the United States, however, rural areas are not the only economically disadvantaged ones—poor urban areas are just as often underserved by ISPs as rural areas (Hawkins, 2005). There have been consistent disparities between rural, urban, and inner-city levels of access, and though strides have been made by both rural and inner-city areas, the divide between these and urban areas is persistent (see NTIA reports, multiple years).

The digital divides that garner the most policy attention in the United States, then, are those of physical access: rural–urban–inner city disparities, along with persistent disparities related to income, education, and race/ethnicity (Hess & Leal, 2001). But some scholars and media activists argue that access should be conceptualized more broadly, by acknowledging that just providing people with the technological resources will not alone make for sophisticated users. Rather, there must also be policies and programs in place to teach the skills necessary to use the Internet and to participate in the information economy (Hawkins, 2005; Lentz & Oden, 2001). As Hawkins (2005) writes, "People must be in the physical presence of ICT, but first, they must be literate, as well as information literate, to effectively engage with the content. A more nuanced understanding of access is imperative to allow for appropriate policies to be developed and implemented" (p. 180).

In terms of the economic consequences, scholars seem to agree that the digital divide exacerbates inequality by limiting yet another avenue for participation in the economy. Not only are communities that lack the Internet excluded from the nationwide online economy, but they also miss out on the social and human capital that flows online, from job training and employment opportunities to civic organization, news, and cultural content (Lentz & Oden, 2001). From research on the digital divide in the U.S., it is clear that informational illiteracy and a lack of Internet access can reinforce other economic and cultural disparities.

Much early public policy focused on overcoming barriers to physical access and setting up Internet infrastructure, with a strong focus on increasing hardware and software ownership in U.S. households (Choemprayong, 2006). While the federal government set goals of universal access, it was the combined efforts of the state government and the private sector that led to success in overcoming these barriers to physical access. As Choemprayong (2006) notes, not only were there government allocations of money to provide computers to underserved communities, but large-scale programs by private-sector corporations have had a huge impact on diffusing Internet access points. Beyond hardware and software in individual homes, policies and programs in the U.S. have focused on access in public schools and libraries, as well as on community access and infrastructure to help close the digital divide (Choemprayong, 2006; Kaiser, 2005; Kvasny & Keil, 2006).

As physical access has increased in schools and communities, the income, educational, and racial divides have lessened, though they have not disappeared (National Telecommunications and Information Administration, 1995, 1998, 1999, 2000, 2002,

2004). Both Choemprayong and Frieden claim that much of the early success in the U.S. was due to constructive co-operation between the government and the private sector: the government helped to fund and provide tax benefits for, but did not otherwise interfere with, those projects best suited to private-sector development. However, that balance has been unsuccessful in later stages of infrastructure development—specifically in the realm of broadband (Choemprayong, 2006; Frieden, 2005). Despite strides in infrastructure development and ISP competition, the U.S. is frequently considered to lag far behind in its development of broadband networks. And though President Bush, in 2004, declared a plan to have universal broadband penetration by 2007, the U.S. was ranked only 15th among OECD countries in terms of per capita broadband access by that year (MSNBC, 2004; Organisation for Economic Co-operation and Development, 2009). Scholars suggest that this is due to a combination of factors—from dot.com failures in 2001, to legislative problems, to disagreements among the current telecommunications operators, new media firms, and civic groups.

The case of the U.S. is particularly interesting due to the certainty of some policymakers and public figures that the digital divide has been effectively closed (Cha, 2002; Marriott, 2006). Many scholars and community advocates disagree, arguing that serious gaps remain and that larger-scale changes are necessary to truly combat the forces that cause the digital divide (Hawkins, 2005). This contrast between the views of scholarship and political leadership provides an interesting backdrop as we examine the differences and similarities between Canada and the U.S., because although they share some features (for example, large rural populations and underserved indigenous populations; see Frieden, 2005), there are certainly differences in the way policy has been formulated and implemented in both countries, particularly in political attitudes toward the digital divide.

In sum, policymakers in the United States largely consider the digital divide in physical terms: there are geographical, economic, and sociocultural factors that can predict disparities in access between the information-rich and information-poor. Early policy focused on setting up infrastructures in homes, schools, and communities; later policy, somewhat less successfully, has sought to increase broadband penetration. Compared with Canada, less governmental attention has been paid to digital literacy and issues of cultural content online, though these appear to be areas served by private foundations, including the Gates and MacArthur foundations.

Comparing digital divides

Tables 1 and 2 summarize the important points of contrast between the types of digital divide and public-policy approaches toward improving access to the Internet in Canada and the U.S. There are interesting similarities and differences in the policy environments and Internet use patterns, the primary instances of digital divide, and the major public-policy initiatives to help overcome these divides.

In both countries, national, subnational, and municipal governments support Internet use in different ways. In Canada, provinces and municipalities establish funds and oversee libraries, community centres, and education. For example, Ontario has a Ministry of Tourism, Culture and Recreation and a Ministry of Education. In the United

States, charities and private foundations do a significant amount of this work. Table 2 identifies only the major, federal public-policy initiatives to encourage Internet access.

Both Canada and the United States privatized their national telephone companies several decades before the Internet became a widely used technology. In both countries, the national telecommunications regulators—the Canadian Radio-television and Telecommunications Commission (CRTC) in Canada and the United States' Federal Communications Commission (FCC)—were depoliticized well before the Internet became a major communications infrastructure. Experts agree, however, that

Table 1: Internet use and telecommunication policy in Canada and the U.S.

Attribute	Canada	U.S.
National Telecommunications Provider	Privatized before 1960.	
Regulatory Authority	CRTC de-politicized in 1992, but not separated from the executive branch.	FCC de-politicized in 1992, but not separated from oversight by the executive branch; politicized in 2000.
Market Competition	Open competition in commercial long distance services in 1988.	
Internet users per 1,000 people		
1990	4	8
1995	42	94
2000	421	441
2005	679	663
Broadband users per 1,000 people		
1998	5	3
2000	46	25
2005	199	172
Government investment in telecommunications infrastructure per $1,000 of GDP		
1990	$7.08	$3.58
1995	$4.21	$3.21
2000	$5.84	$7.60
2005	$4.29	$2.06a
Government investment in telecommunications infrastructure per 1,000 people		
1990	$132.32	$80.61
1995	$89.48	$87.43
2000	$161.07	$261.15
2005	$143.19	$81.31a

Note: a) Based on 2004 data.

Sources: Government of Canada, 1997; Henisz, Zelner, & Guillen, 2005; Industry Canada, 2006; International Telecommunications Union, 2007; Organisation for Economic Co-operation and Development, 2009; United States Bureau of the Census, 1997, 1998, 2000, 2001; World Bank, 2007.

the FCC was re-politicized in 2000, with the appointment of political-party advocates over technocrats and policy experts to the Commission (Henisz, Zelner, & Guillen, 2005). While international lending organizations, such as the World Bank and International Monetary Fund, often make the formal separation of regulatory authority from the executive branch a condition of loans to poor developing countries, this reform has actually not occurred in wealthy countries such as Canada and the United States. Both countries opened their local markets for long-distance services in 1988.

Table 2: Digital divides and public-policy initiatives in Canada and the United States

Attribute	Canada	United States
Primary Digital Divides		
Demographic	Income, education, race	
Geographic	Rural and urban disparities	Rural, urban, and inner-city disparities
Socio-Cultural	French and Innu language groups	Spanish language use divide: English-dominant & bilingual Latinos go online at same rate as non-Hispanic whites (above 70%), but only 32% of Spanish-dominant Latinos go online (as of 2007).
Major Public Policy Initiatives up to 2008		
Federal Spending	Connectedness Programs (includes CAP, SchoolNet, Smart Communities Program) were $637.3 million from 2001-2003 with a $120 million five-year grant awarded to the CAP and SchoolNet initiatives in 2006-2007 fiscal year. Additional budgets in other branches.	At least $13.4 billion on three programs explicitly targeting technology in schools and libraries (E-Rate, Community Technology Centers, and Technology Opportunity Program. No Child Left Behind also provides funding for technology in schools, but as portion of overall budget.
Goals and Strategies	Universal and affordable access, lifelong learning and skills, job creation, increased competitiveness and economic growth, development of Canadian cultural content, benefits from electronic commerce, access to government and other public services and information online	Early goals centred on universal service and access, especially focused on schools and libraries; more recent goals have centered on broadband, including rural broadband access. President Bush declared a 2004 goal of universal broadband access by 2007.
Observed Outcomes	Canada 2nd in broadband penetration until 2003; ranked 6th in 2005. Ranked 6th amongst OECD countries in terms of lowest available broadband pricing. Ranks 2nd to last in OECD for wireless penetration.	99% of schools and 92% of classrooms had Internet access by 2003, but E-Rate program considered underperforming and there have been allegations of fraud; U.S. ranked 1st among OECD in total number of broadband subscribers in 2006, but ranked 15th in per capita broadband subscription.

Both countries have similar levels of per capita Internet use today, though Canada, which lagged through the 1990s, has since surpassed the U.S. both in terms of general Internet use and broadband access. The more striking contrast is in public investment patterns. While the Clinton administration made significant infrastructure investments in the late 1990s, Canada consistently invests more in infrastructure, whether assessed in dollars of investment per $1000 of GDP or per capita.

In both countries, Internet use consistently varies by income, education, and race. While there has been an urban and rural digital divide in both countries, in the United States there are also inner-city disparities in New York, Los Angeles, Chicago, and other dense urban centres. Both countries have a language divide in Internet use: the largest, English-speaking populations consistently have greater levels of Internet use than the second-largest language groups (French in Canada and Spanish in the United States) and among smaller minorities, First Nations, and Innu communities.

It is difficult to estimate how much has been spent directly on digital divide initiatives. Both Canada and the United States committed some public funds at the federal level, but probably more spending per capita comes from state or provincial and municipal governments. Moreover, in the United States a significant number of private foundations have supported digital access and literacy programs. Data on personal computer and Internet use in these two countries goes back to at least 1995. Different sources, such as the International Telecommunications Union, the World Bank, and Statistics Canada, report different trend lines, so care must be taken to assemble comparable data on important variables such as economic growth, telecommunications policy, demographics, and infrastructure. But how can we assess the comparative impact of different kinds of policy reforms in Canada and in the U.S.? Is the digital divide closing in the two countries, in what respects, and why?

Comparing public-policy impact on the digital divide

Technology resources are not evenly distributed among countries and peoples. One common way of measuring how evenly a resource is distributed is through Gini coefficients (Milanovic, 2005). Economists often use Gini coefficients to represent the distribution of income within a country. We have adapted the Gini coefficient to create an index of the distribution of Internet access within Canada and the U.S. (Atkinson, 1970; Berrebi & Silber, 1985; National Telecommunications and Information Administration, 2002).

For example, in a perfectly equal society, 23% of the population would be using 23% of the Internet bandwidth or have access to 23% of the Internet-enabled computers, and 90% of the population would be using 90% of the Internet bandwidth or have access to 90% of the Internet-enabled computers. A more equal society will have a low Gini coefficient close to 0.00, and a society in which resources are highly concentrated will have a high Gini coefficient close to 1.00. Within the United States and Canada, Gini coefficients could range from equal IT distribution across a sample of states or provinces to a condition of complete inequality in which all IT resources are held by one state or province.

The mathematical expression for a Gini coefficient of the distribution of Internet users among Canada's provinces in a given year is shown below in Expression A, where μ_i represents the mean unweighted average number of Internet users in each

country and 1/*n* represents the weight of each province (*n* being the number of provinces). All provinces are ranked by the number of Internet users residing there, so that $y_j > y_i$, and the relative difference between the number of Internet users in two provinces, $y_j - y_i/y_i$, is weighted by the product of the province with the smallest (i^{th}) share of Canada's Internet users and the province with the largest (j^{th}) share of Canada's Internet users. This formula renders a measure of the distribution of Internet users among Canada's 10 provinces (territories excluded).

Expression A: Gini coefficient for the distribution of Internet users by Canadian province

$$Gini_T = \frac{1}{\mu_i} \bullet \frac{1}{n^2} \sum_{i}^{n} \sum_{j>i}^{n} (y_j - y_i)$$

For example, one approach to studying the distribution of Internet access in these two countries is to measure its distribution across states and provinces. Doing so with data from the year 1998 renders a Gini coefficient of 0.57 for the distribution of Internet access among households across 10 Canadian provinces and 0.52 in the United States for the distribution across 50 states. Computing the distribution of Internet users this way treats all Canadian provinces as equivalent and all states as equivalent, so it is useful as a way of measuring the distribution across comparable government units or geopolitical territories such as provinces or states.

Yet in terms of population, the two largest provinces, Québec (7.8 million) and Ontario (12.9 million), are home to about two thirds of the Canadian population. In the United States, the two largest states, California (36.5 million) and Texas (24.3 million), are home to about one fifth of the U.S. population. Since provinces vary quite significantly in terms of population, it would be more accurate to weight the Gini coefficient for the distribution of Internet users by the relative portion of Canada's population residing in each province. This expression allows us to weight the relative contribution of provinces with different populations and different numbers of Internet users. In other words, Expression B allows for a more accurate fit between large and small provinces with proportionally many or few Internet users.

Expression B: Gini coefficient for the distribution of Internet users by Canadian province, weighted by provincial population

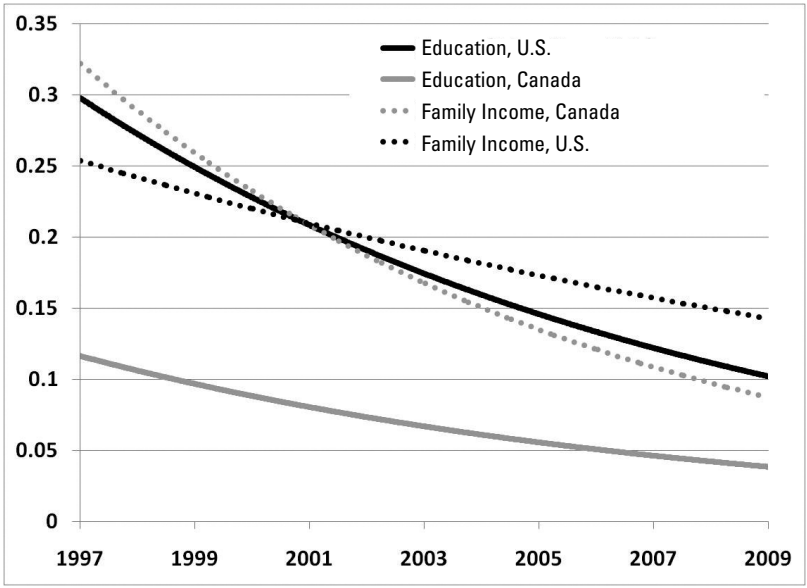
$$Gini_T = \frac{1}{n^2} \sum_{i}^{n} \sum_{j>i}^{n} (y_j - y_i) p_i p_j$$

For 1998, the population-weighted Gini coefficient for the distribution of Internet use among Canadian households is 0.01, and for the United States, it is 0.03. From this example, we can conclude that Internet users are concentrated in a few provinces and states, and the level of concentration is somewhat greater across the Canadian provinces than the U.S. states. However, when weighted by population size, Internet users are almost perfectly distributed across these provinces and states, though Internet users are somewhat more evenly distributed across the Canadian provinces than the U.S. states.

Figure 1 illustrates that across categories of income and education, the digital divide has been closing over time. The pace at which digital divides are closing, however, varies by category of social inequality and country. Data quality varies from year

to year and source to source, so this figure presents only the trend lines for Gini coefficients we were able to compute from the most internally consistent survey projects.[1] There are other categories of social inequality that could be evaluated this way, but we chose to work with the three most pronounced ones as suggested by existing scholarship. Conceptually, a bivariate category such as rural–urban or male–female cannot be rendered as Gini coefficients. Education, income, and state or province have multiple categories and are thus easier to work with. For example, in many of the surveys we worked with, income is measured in $10,000 increments.

Figure 1: Closing the digital divides for education and income in Canada and the United States, 1997-2009



Note: These are population-weighted Gini coefficients, calculated as described above in formulation B, using multiple sources of survey data. Only the most internally consistent data points for coefficients for education and income in Canada and the U.S are plotted here, and since the Gini coefficients for the distribution of internet users across provinces and states is consistently small—users are evenly distributed—this trend is not plotted. The full set of data points is presented in tabular form in Note 1.

Internet users are more evenly distributed across income categories today than they were 10 years ago. But over time there has been an interesting transition. At first, Internet users were more concentrated by income in Canada than in the United States. Over time, as Internet access diffused, the level of concentration dropped in both countries, but more dramatically in Canada. By the most recent measures, Internet access is more concentrated among wealthy families in the United States than in Canada. In terms of comparative outcomes, Internet use in the U.S. is more concentrated among the highly educated than it is in Canada. Over time this level of concentration has diminished, but the Gini coefficients remain about twice as high in the U.S. as in Canada.

When weighted by population, it turns out that Internet access is well distributed among Canadian provinces and among states in the U.S. For the most part, Internet users in Canada are more equally distributed among education levels in the United States, where Internet users are relatively more concentrated among the cohort of highly educated people. Originally, Internet use in Canada was concentrated among families with higher levels of income, but over the period of available data, Internet access has become distributed across all income categories. In the United States, Internet use has also become more evenly distributed across income categories. Today, Internet use is not really concentrated by geography in either country; Internet use is somewhat concentrated among people with higher levels of education, more so in the United States than in the Canada; and Internet use is more concentrated among people with higher levels of household, personal, or family income, more so in the United States than in Canada.

Conclusion

Canada and the United States have had different approaches to improving access to new information and communication technologies. In the United States, public policy and falling access costs have helped to close very significant digital divides in a relatively short period of time. In this article we demonstrate ways of measuring the digital divide over time for three categories: political territory, income, and education.

Although our focus has been on making a methodological contribution, the policy literature on the digital divide in Canada and the U.S. helps explain causes and consequences of the digital divide in these two countries. In Canada, public-policy oversight and public investment have been used to encourage Internet diffusion in rural areas and to support the production of French- and indigenous-language content, while relying on markets to bring the Internet to dense urban areas. In the United States, public initiatives have encouraged Internet use by the urban poor and improved access more generally through schools, libraries, and community organizations. Whereas public policy in the United States is focused largely on physical access (but not broadband access), government policy in Canada includes the promotion of digital literacy and the development of cultural content online. Can we measure the outcomes of these different public-policy strategies in a comparative manner? In this paper, we find that our comparative techniques result in measures that are both internally consistent and consistent with scholarship on the single-country case studies.

In Canada, the digital divide by income has been closing, but it remains more serious than the digital divide by education. In the United States, the degree of concentration in Internet access among top education categories is matched by the degree of concentration among top income categories. Internet access has become socially valuable, and many of the technologies for connecting to the Internet have become more affordable. Yet policy initiatives have sought to encourage Internet use where competitive markets alone were not allowing technology diffusion. On the whole, we found that Canadian public-policy initiatives have done more to close the digital divide in Canada than corresponding initiatives in the U.S., and overall, it appears that some public investment in Internet infrastructure and public education is a wise strategy. Digital divides may persist if the state retreats too much from investment in public

goods such as telecommunications infrastructure, informational literacy, and cultural content production.

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Note

1. This Table provides the full set of Gini coefficients computed for three categories of social inequality. These are computed using the Gini coefficient for population-weighted provinces and states.

	Provinces/States		Education		Family Income	
Year	**Canada**	**USA**	**Canada**	**USA**	**Canada**	**USA**
1997	0.02[a]		0.11[c]	0.33[a]	0.29[d]	
1998	0.01[a]	0.029[a]	0.10[c]	0.33[f]	0.30[a]	0.26[d]
1999	0.00[a]		0.11[c]		0.26[a]	
2000	0.01[a]	0.09[c]	0.26[f]	0.22[a]	0.23[d]	
2001	0.02[a]	0.007	0.08[c]	0.15[f]	0.19[a]	0.17[d]
2002	0.03[a]		0.08[c]		0.19[a]	
2003	0.01[a]	0.012	0.06[c]	0.14[f]	0.18[a]	0.15[d]
2004	0.01		0.13[e]		0.00[b]	
2005	0.01					
2006						
2007	0.01	0.00	0.19		0.18	
2008	0.00		0.09		0.16	

Sources: Government of Canada, 1997; Henisz et al., 2005; Industry Canada, 2006; International Telecommunications Union, 2007; National Telecommunications and Information Administration, 2002; Organisation for Economic Co-operation and Development, 2009; Pew Internet and American Life Project, 2008; Statistics Canada, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2005, 2007a, 2007b; United States Bureau of the Census, 1997, 1998, 2000, 2001; World Bank, 2007; Zamaria & Fletcher, 2005.

Notes: a) Indicates unit of analysis was household, rather than adults or family; b) For these income categories in Canada, the actual values of quartiles changed over time as incomes changed; c) In these years, the sample frame was restricted to the head of the household; d) Indicates the unit of analysis was family, rather than adults or household; e) This data point is from Canadian Internet Project, 2004, and it is so inconsistent with trend lines that it is omitted from Figure 1; f) These data were restricted to the educational attainment of people age 25 and older, as younger people are most likely to still be in school.

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