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ORIGINAL ARTICLE

The internet as a celestial TiVo: What can we learn from cable television adoption?

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Abstract It appears that the Internet is soon going to fulfill its potential to become a giant on-demand repository of television shows (and movies) available asynchronously, greatly increasing the variety of shows available at a moment in time. As companies such as Netflix and Hulu increase their activities in this sphere, there are many unanswered questions about the impacts of this transition. In this paper, we attempt to foretell the impact of Internet-induced increased variety on the amount of time individuals devote to viewing television. We use cable and satellite television's impact on viewing as a proxy for the likely impact that future Internet transmission of programs will have. Using country-based panel data going back to the mid-1990s, we find that the increased variety brought about by cable and satellite has had virtually no impact on the amount of time devoted to television viewing. We discuss the import of this finding for Internet business models of television transmission.

Keywords Television viewing · Internet adoption · Product variety

Recreational activities are often greatly changed by new technologies. Beginning with Gutenberg's printing press, new forms of entertainment have been created by technological advances, including the leading recreational activities of the last century—watching movies and television and listening to radio. These then-novel forms of entertainment diffused throughout countries and populations at varying rates depending on wealth, technological sophistication, government policy, and other country characteristics.

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The Internet is the current new technology that has changed many aspects of daily life (Brynjolfsson and Smith 2000; Goolsbee 2000), including communication, advertising, distribution, and the focus of this paper, television viewing. The Internet is likely to have several important impacts on television viewing. One, which is examined in Liebowitz and Zentner (2012), is the substitution of the Internet as a form of entertainment that competes with the types of programming watched on television. A second influence is the impact of Internet piracy on the markets for movies and television programs (Liebowitz 2014). A third influence, related to but not directly caused by the Internet, is the impact of increased portability having to do with the ability of portable video-players, for example in the form of smart phones, to play back both streaming and saved video programming.

Our interest in this paper is to examine a forth impact: How the increase in programming variety caused by the Internet is likely to influence the time spent viewing television programming. Online sites such as Netflix and Hulu have showed how the Internet can outdo what cable and satellite have done in terms of providing greater variety and choice to viewers. It is not yet clear, however, which business models and firms are going to succeed in this new mode of transmission.

The prior variety enhancing technological disruption in television markets was the introduction of cable and satellite transmission. Those technologies provided a much larger number of channels than had been available with over-the-air transmission, but the viewing of a program was still synchronized with the transmission of the program. Many cable channels repeated their programming on different days or times in the hopes of reducing the limitations of this synchronization. Recording devices, such as the TiVo also attempted to break this synchronization limitation by "time shifting" the program, recording it at one time and playing it back at another. In recent years, many cable systems also have provided a form of asynchronous "on-demand" service that allows viewers to view a small subset of cable programs when they want, as opposed to having to watch them when broadcast.

Internet-based services, because they can entirely sever the synchronization limitation, can considerably improve the set of viewing options relative to any of these older technologies. This change fits hand-in-glove with a vision that every consumer would have the world's supply of music available to them at any time, a vision that Goldstein (1995) referred to as the "celestial jukebox." This concept could apply equally well to video programming and, in fact, all forms of digital entertainment.

In this paper, we take a first stab at determining how the greater variety made available by the Internet is likely to alter television consumption. We examine how a previous increase in the variety of television programs changed the consumption of television programming. We take the past impact of the additional viewing choice made available by cable and satellite as a harbinger of the future impact of Internet-based networks on viewing behavior.

We use panel data on the television viewing habits in various countries over a 13-year period when cable and satellite were rapidly expand their penetration, from 1996 to 2008. Using viewing data in conjunction with data on cable and satellite penetration, Internet usage, income, and several other variables, we are able to measure the extent to which the additional viewing choices made available by cable and satellite affected television viewing.

We acknowledge that the Internet's alteration in viewing choice will of course be somewhat different than the change in viewing choices made possible by cable and satellite transmission. The change made possible by cable and satellite was from a few over-the-air broadcast networks or stations, following a fixed schedule, to a much larger number of networks (sometimes as high as a few hundred) also generally following a fixed schedule except for, in the last few years, a small amount of "on-demand" programs or programs recorded on a DVR.[1] The Internet, by contrast, will make extensive repertoires of existing programs available at any time, breaking the synchronicity bind that has previously limited the viewing of programs to the current playing schedule.

It is difficult to know and impossible to precisely measure whether the Internet's breaking of this scheduling bind, and its inclusion of many older programs in the viewing library, can be considered more or less consequential to viewers than was the increased choice provided by cable/satellite broadcasters compared to over-the-air broadcasting television. While this is obviously a limitation of our study, we argue below that the increase in viewing choice brought about by cable and satellite is large enough that it should provide useful information about what we might expect from the increased choice to be brought about by the Internet.

Our results, in short, are that all else equal, the greater number and variety of networks and programs on satellite/cable appears to have had virtually no impact on time spent viewing television. Thus, Internet business models aiming to take advantage of their new technology may need to focus on appropriating some of the extra value consumers receive from the additional choices and not expect to make additional revenues or profits through a greater quantity of viewing, since competing on quantity appears to be a zero-sum game. In other words, focusing on subscription revenue will likely be more important than focusing on advertising revenue.

Showing that increased variety does not alter the amount of television consumption is not only important for evaluating the effect of Internet-induced increased variety on television viewing, but might also provide strategic business insights for other industries. Consumers nowadays have a large number of choices for many product categories including products as diverse as movies, supermarket ice cream, beer, candy bars, and automobiles. These industries might share the television industry's characteristic that more variety might not increase the overall amount of consumption but merely shift consumption toward choices that better fit each consumer's taste.

The outline of the remainder of the paper is as follows. The next section studies the possible impacts of product variety on television viewing. The relatively small amount of research studying television viewing with respect to viewing choice is summarized in Sect. 2. Section 3 provides some details about the data that we use. In Sect. 4, we summarize univariate statistics from the data. Section 5 lays out the model and the empirical strategy. Section 6 presents the multivariate estimation

[1] The cable/satellite networks have also responded to the scheduling bind by providing several channels with similar programs playing at different times.

results, and Sect. 7 discusses the implications of those results for business models. The last section offers some conclusions.

1 Possible impacts of program variety on television viewing

Although it seems to be commonly believed that greater choice should lead to greater consumption of the product, this need not be the case.[2] Even assuming that consumers can easily navigate a plethora of choices to find the specific variants of the product (programming) that they most value, the fact that consumers derive greater value from their chosen consumption choices (television programs) when they are better able to find variants that match their tastes does not necessarily imply that they will consume a greater amount of the category (more hours of television).[3]

In the simplest case, the binding constraint on television viewing might be one of time. Because consumers (viewers) get more value for each unit consumed (e.g., an hour-long television program), the demand for viewing hours might increase but a binding time constraint would fix the number of viewing hours even as the value of the programming increased for both the marginal and inframarginal consumption units (television programs). Viewer willingness to pay would increase, but viewing time would not.

On the other hand, if we think of television programs as providing various "characteristics," a la Lancaster (1966) or "services" a la Hirshleifer (1971), then an increase in a variety of programs available to consumers will allow viewers to consume a greater amount of services for a given viewing hour. This does not, however, lead to an unambiguous increase in the demand for viewing hours on the part of consumers. The demand for viewing hours will tend to rotate clockwise when choice increases as each viewing hour provides a greater amount of services, in which case satiation of these services occurs at a smaller number of viewing hours.[4] In other words, the first hours of program viewing have greater value because those programs contain more units of the still high value "viewing services." But later hours of viewing, although they contain more services, have

[2] This presumed positive relationship between greater choice and greater consumption is evident in the discussions of "sampling" in the context of file-sharing. Sampling would occur when music listeners test out songs on file-sharing networks with the intention of purchasing music that they discover through this trial and error process. The claim is usually that sampling will increase demand for purchased music because consumers acquire more information about the choices available to them. But sampling, even if it occurred, would not necessarily increase the quantity of music consumed, since it merely increases the quality of each song purchased but does not necessarily increase the amount of time listening to music or the quantity purchased for the reasons explained in the main text.

[3] There is even currently a question of whether viewers actually derive greater benefit from greater choice. See Benesch et al. (2010) and also Bruni and Stanca (2008) who suggest that greater choice has increased television viewing and lowered overall utility because viewers have less time to interact with other people. Our analysis suggests that greater choice might not lead to greater viewing and thus it might not reduce the "relational" interactions at the heart of their analysis.

[4] This rotation does not hold in every possible instance. For example, in the case of a constant unit elasticity of demand for services, the quantity demanded of units (programs) would be fixed and would not rotate clockwise.

lower values than they did with less program choice because those units of service are much further down the demand curve for services.

However, if each television program has unique (heterogeneous) characteristics that do not substitute for characteristics (services) found in other television programs, then these models that assume that all programs have different combinations of identical characteristics are no longer appropriate. In this case, an increase in programs that better meet the needs of consumers will increase both the consumer willingness to pay and the quantities consumed at a fixed price, if there is no binding time constraint.[5]

Finally, more viewing alternatives might lead to a decrease in television viewing when there are search costs of evaluating each alternative. There are models in the marketing literature (e.g., Kuksov and Villas-Boas 2010), and there is also some empirical evidence from both field and laboratory experiments (e.g., Iyengar and Lepper 2000), showing that consumers may reduce their consumption when they are given a larger number of choices.

This admittedly brief examination should make it clear that whether additional variety of programming would increase or decrease television viewing is an open question from a theoretical perspective. Nevertheless, the basic expectation has generally been that greater choice will increase consumption. This basic intuition has been at least somewhat supported by the small empirical literature that has examined the relationship between viewing choice and viewing hours.

2 The literature

There is a small literature on the impact of program variety on television viewing. Some studies report the common finding that cable viewers watch more television than over-the-air viewers and inappropriately assume causation, ignoring the possibility that heavy viewers are more likely to be drawn to cable. At the introduction of cable in North America, Park (1979) attempted to estimate the causal impact of cable on viewing hours, but although the results supported an interpretation that cable increased viewing, he remained skeptical of that result. Liebowitz (1982) compared the link between viewing hours and cable penetration across different Canadian metropolitan areas and found an insignificant and sometimes negative relationship. In those days, however, the number of channels on cable was rather small and tended to consist of distant over-the-air stations and a handful of pay networks.

Similarly, the introduction of cable in Europe led to some assessments of its impact on viewing. For example, a German government experiment in the mid-1980s, reported in Noelle-Neumann and Schultz (1989), found that in the few small geographic areas examined, the introduction of cable appeared to have increased viewing by 7.5 % (from 133 min per day to 143 min per day). Recent work by

[5] If the nature of the programs is considered ‘unique’ to each program, then watching an additional program does not bring the consumer closer to satiation with regard to other programs.

Benesch et al. (2010), trying to determine whether there is overconsumption of television, has relied on these claims that increased choice led to increased viewing.

Perhaps the most extreme instance of increased variety is the study by Weimann (1996) who examined viewing in Israel (based on his own surveys and samples) after the introduction of a relatively modern multi-channel cable system where previously there had been but a single (public) channel. This is a more extreme increase in choice than can be found almost anywhere and should provide something of an upper limit of increased viewing due to greater variety, since variety (as measured by the choices that exist at a moment of time) starts from the lowest possible level and increases to a more modern number of channels. A year after cable was introduced, viewing time for cable subscribers increased by 32 min from a base of 94 min per day, an increase of 33 %.

Our study is, to our knowledge, the first to examine the impact of variety on viewing time by using a panel of countries over a multiyear period. Using countries as the unit of analysis provides large cross-sectional variation and, hopefully, more precise estimation. It also measures the impact of choice on viewing for a considerably wider group of viewers than has previously been the case. Additionally, the number and variety of cable and satellite channels is much greater than in the early days of cable television when most previous analyses were undertaken. Finally, unlike many previous studies that took snapshots before and immediately after the introduction of cable, our results will be largely immune to potential transient responses to a new technology (cable) that might have influenced some of the previous studies.[6]

3 The data

Our data cover the period 1996–2008. In all we have data for 52 countries (and data for three more observations for the double-language Belgium and triple-language Switzerland).[7] We acquired data on cable and satellite penetration from IHS Screen Digest.

Our dependent variable, country-level television viewing measured in daily average number of minutes per capita, was acquired from Mediametrie–Eurodata TV Worldwide. While the measuring methodology is proprietary, the company proving the television viewing data reassured us that viewing is based to a large extent on meters attached to televisions.[8]

The metric we have chosen as a proxy for the key variable of available program variety is the share of the population with subscriptions to cable or satellite. Cable and satellite programming contains a much greater variety of programs than is

[6] Weimann (1996) reports a larger initial impact on viewing after 3–4 months after the introduction of cable than was the case at the end of 12 months.

[7] The list of countries can be found in the "Data Appendix".

[8] For example, Mediametrie–Eurodata TV Worldwide is the source of the data used in the reports from the European Audiovisual Observatory (a non-profit public service institution under the auspices of the Council of Europe with participation by the European Union). See Liebowitz and Zentner (2012) for an explanation of the various methods used by companies to measure television viewing.

available over-the-air. Before the advent of Internet transmission, viewers without cable and satellite were restricted to a small number of traditional over-the-air television broadcast signals. Over-the-air signals can travel only limited distances, often covering little more than a single large-sized metropolitan area.[9] Rural residents often had no access to over-the-air signals. By contrast, cable and satellite signals tend to have hundreds of channels, an order of magnitude more channels than would be available over-the-air. Although cable and satellite signals are often sold in packages, even the packages with the smallest number of signals usually contain several dozen, which is still far more than are likely to be available over-the-air. Because the difference in the number of choices is so great between over-the-air and cable/satellite reception, we treat the latter as providing far greater variety than the former.[10] Because cable and satellite subscriptions tend to carry the same or similar number of networks to one another, we have merged the two together into a variable called "CabSat" that measures the sum of the penetration rates of cable and satellite.[11]

Another important independent variable is the Internet penetration rate taken from the International Telecommunication Union (ITU), a United Nations agency for information and communication technology issues. The Internet variable is included because the Internet is an increasingly important hub for new entertainment activities, such as social networking or online game playing. To the extent that the Internet provides substitutes for traditional entertainment, as opposed to merely replacing the hardware locus of an already existing entertainment (such as switching radio listening from over-the-air to the computer), it can be expected to alter the time spent on more traditional entertainment. Ideally we would like to have a measure of the time spent using the Internet for entertainment purposes, since this would most directly impact the time spent viewing television. Such a measure does not exist, however. Given the wide variation in Internet penetration rates, the assumption that countries with higher rates also have higher per capita amounts of time being entertained through the Internet seems quite reasonable. Internet penetration was very low in 1996, the beginning of our time period, and grew greatly over the period.

Income is likely to influence the time spent viewing television programs since it is related to the ability to purchase a television, the quality and size of a purchased television, and the number of available channels through an outdoor antenna, cable, or satellite. Income also influences the opportunity cost of time spent watching television and the ability to participate in other costly forms of substitute entertainment activities. Thus, the direction of the relationship between Income and television viewing is unclear. The measure of income that we use is constructed

[9] In the USA, for example, the Nielsen company creates what are known as "designated market areas" based on the contours of the distance from the transmitter where the share of the population capable of receiving the signal dropped below a standard threshold.

[10] A metric for variety is difficult to construct or defend since it would involve not just the number of choices but also the degree of "sameness" of those choices.

[11] Although there could in theory be some double counting, we are doubtful that there are many households with both satellite and cable because the two distribution systems carry much duplicative programming.

by combining the purchasing power-adjusted GDP per capita (normalized to the US dollar) for a base year (we use 2000) and growth rates of GDP in local currency in constant values, and is based on data from the International Monetary Fund World Economic Outlook Database. A potential confounding influence when examining the relationship between national average income and average television viewing might have been due to income altering the portion of population being measured as more families acquired televisions. Fortunately, television penetration was at already high levels, above 85 % of the population, for almost all of the countries in the sample, except for a few less developed countries in the early years of the period under investigation.[12] Importantly, this means that the viewing data represent almost complete swaths of the population in most of the countries during the period of this investigation.

Another variable that seems likely to be related to the extent of television viewing in a country is the share of the population having a job (from the World Bank). One constraint to television watching, and perhaps the only binding constraint, is the amount of time available for television watching. Adults who are not at work have more free time and thus more time to watch television. In support of this proposition, Liebowitz and Zentner (2012) document that Americans over 65, a group with a high percentage of retired individuals, watch far more television than do younger Americans. Of course, the share of the population employed may have very little variation across countries or years and thus may not influence television viewing in an important way. Additionally, the share of population employed may also be a barometer for current macroeconomic conditions and as such might have a different impact on television viewing than just envisioned. Nevertheless, because most countries have positive temporal correlations in their macro economies, we think that the year fixed effects in the regression analysis will pick up much in the way of macroeconomic fluctuations.

We also include population in the regression since economies of scale in producing and transmitting television programs might mean that large countries are more likely to have television programs created to fit the particular tastes and culture of the population, whereas small countries might need to import most of their programming. Nevertheless, it is not clear how this might translate into viewing time since programs better tailored to the audience might actually decrease television viewing, as discussed above.

Finally, we also examine cell phone penetration (from the ITU). We include this variable because cell phones are often thought to be an important source of entertainment, particularly for young individuals, implying that greater cell phone penetration might reduce television viewing. Conversely, cell phones might increase television viewing when they are used to watch television. We expect, however, these cell phone impacts to be limited over the 1996–2008 period since smartphones were only in their infancy by the end of our study period (e.g., the iPhone was not introduced until 2007 in the USA and 2008 in Europe).

[12] By 1999, all the countries but Latvia (at 80 %), India (at 28 %), Moldova (81 %), and South Africa (56 %) were in the range of 85 % or above for the share of households owning a television.

Table 1 Summary statistics

Year	Internet penetration %		GDP per cap thousand $		Population (millions)		Share employed %		Cell phone penetration %		Countries
	Avg.	SD	Avg.	SD	Avg.	SD	Avg.	SD	Avg.	SD	*N*
1996	3.32	4.26	15.67	9.55	71.34	210.43	52.65	7.41	7.53	8.31	54
1997	6.16	6.66	16.19	9.83	72.08	213.23	52.77	7.45	11.45	10.96	54
1998	9.96	10.13	16.54	9.97	72.80	215.92	52.85	7.36	17.06	14.29	54
1999	14.58	13.92	16.96	10.30	73.53	218.49	52.64	7.34	26.58	19.36	54
2000	19.90	16.85	17.63	10.65	74.28	220.99	52.63	7.48	39.30	25.94	54
2001	23.53	18.64	17.86	10.67	75.05	223.44	52.70	7.63	48.49	28.59	54
2002	30.73	22.49	18.15	10.73	75.73	225.82	52.52	7.47	55.07	29.49	54
2003	35.10	23.68	18.48	10.71	76.43	228.14	52.42	7.29	61.69	30.23	54
2004	38.74	24.16	19.12	10.92	77.11	230.44	52.46	7.06	69.94	29.94	54
2005	42.08	24.41	19.69	11.06	77.78	232.73	52.71	6.95	80.03	29.69	54
2006	45.63	24.33	20.40	11.23	78.41	234.93	53.26	6.97	89.85	29.46	54
2007	50.18	24.55	21.14	11.38	79.09	237.14	53.46	6.86	100.13	29.69	54
2008	53.82	24.30	21.25	11.21	79.78	239.33	53.44	6.82	107.37	29.45	54

4 Summary statistics

We were unable to obtain complete country data for every variable and year. This complicates the analysis somewhat although we attempted to ensure that our results were not dependent on particular cohorts of countries, or years, or variables, for which the data were incomplete.

Table 1 presents means and standard deviations for those variables with complete data for every year and every country and country-language permutation (54 "countries" as indicated in the rightmost column).[13] These variables include Internet penetration, income, population, the share of the adult population that is employed, and cell phone penetration.

The first pair of columns indicates that the average Internet penetration variable grew dramatically, from 3 to 54 %, with a fairly constant increase that showed little indication of a slackening as of 2008. The relatively large standard deviations, particularly in the early years, revealed that Internet penetration rates varied widely by country. Although the details are not shown, highly industrialized countries generally have the highest Internet penetrations and less developed countries tend to have the lowest Internet penetration. In the later years, the Internet penetration rates are approaching saturation in some countries, but the substantial idiosyncratic variation across countries should provide sufficient contrast to help identify the relationships of interest.

GDP, measured in constant US dollars, rose quite consistently over this period although there is considerable variation in the size of these economies as indicated

[13] There are 55 countries in the data set, but Serbia is removed from Table 1 because it alone had missing data for these variables.

by the relatively large standard deviations. Population shows a small increase over this time interval, although, again, there is considerable cross-sectional variation reflecting substantial size differences across countries. The share of the population employed reveals only a tiny increase over this time period and fairly little variation across countries. As would be expected, cell phone penetration rates are seen to increase markedly during this period.[14]

Table 2 provides summary statistics for the two variables that are incomplete in some way: the television viewing variable and the CabSat variable. The CabSat variable is almost complete, however, missing data only for three countries for 2 years. Obviously, we would prefer to have had complete data on this important variable, but this is only a minimal deviation from complete data. The TV viewing data are not as complete as the CabSat data, but they do cover most countries most years, particularly after 2001.

The CabSat penetration rates grew quite strongly in spite of the fact that a few countries had CabSat penetration rates near 90 % in 1996 that would limit the amount of any growth possible in those countries. The growth of CabSat penetration over the period was about 23 % points, or about 70 % above its initial value. The variation across countries is also quite high.

Television viewing increased over this period, whether we look at the full data set or a (balanced) data set based on a considerably smaller number of countries with complete data. Viewing increased slightly during this time interval, from just over 3 h per day per person to a level of about 3 h and 25 min. The variation across countries is small, perhaps surprisingly so given the seemingly large differences in the levels of development in these countries as indicated in their income differentials.

As implied by the standard deviations, audiences in the countries with the least time spent viewing television watch about 2.5 h per day whereas audiences in the highest viewing countries are in the vicinity of 4 h per day.

Although we will explore more precisely the relationship between time spent viewing television and the diversity of viewing choice in the regression analysis below, it is instructive to examine the simple relationship between changes in viewing and changes in CabSat penetration. Figure 1 would appear to indicate that there is no clear relationship, certainly not a positive relationship, between changes in the number of channels available (as proxied by changes in cable and satellite penetration) and changes in average time spent viewing television and this is consistent with a linear trendline which, although not shown, is almost flat.[15]

Next we examine cross-sectional correlation coefficients for the year 2002, a year in the middle of the period and for which the sample is well populated with 48 out of 55 countries represented. Although not shown, the year by year correlations are basically similar to those shown here for 2002 (Table 3).

[14] The "Data Appendix" explains why the cell phone penetration rate measured by the ITU has been over 100 % in recent years for several countries.

[15] This is for the 39 countries that had viewing and CabSat data from 1999 to 2008 (the two negative viewing change outliers are Mexico and Cyprus). Cable penetration decreases 11 % in Denmark, and the pattern of the data suggest that this change is likely to have been caused by a change in the data source in year 2000.

Table 2 Summary statistics for incomplete variables

Year	TV viewing (unbalanced)			TV viewing (balanced)			CabSat % (unbalanced)		
	Avg.	SD	Countries	Avg.	SD	Countries	Avg.	SD	Countries
1996	188.1	52.4	28	177.0	33.9	24	34.8	31.4	52
1997	180.8	35.0	33	175.4	33.4	24	36.6	31.3	52
1998	186.9	34.9	37	180.6	34.9	24	39.9	30.6	55
1999	186.9	34.7	41	186.3	33.3	24	42.2	30.4	55
2000	193.0	34.6	44	190.8	32.6	24	44.3	29.9	55
2001	192.3	33.5	47	191.1	33.5	24	46.2	30.3	55
2002	198.9	34.3	49	194.2	34.8	24	47.0	30.0	55
2003	200.9	35.3	51	199.6	38.8	24	48.5	29.5	55
2004	203.1	37.2	51	204.7	40.3	24	51.0	29.1	55
2005	201.4	39.0	50	205.7	42.1	24	52.6	28.3	55
2006	205.3	38.7	55	203.3	38.7	24	54.6	28.1	55
2007	205.1	39.0	54	200.9	39.2	24	56.5	27.2	55
2008	208.4	38.5	54	203.2	36.7	24	58.2	26.4	55

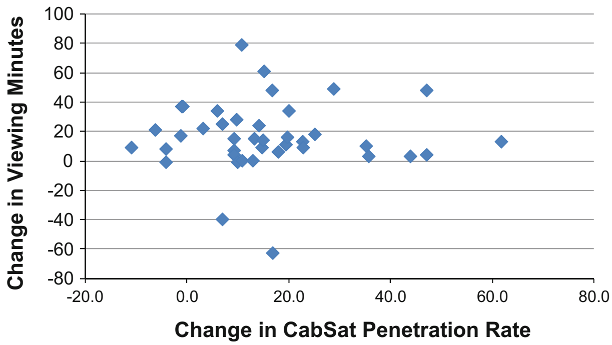

Fig. 1 CabSat versus viewing 1999–2008

There are moderate negative correlations between TV viewing and all the other listed variables: Internet penetration, CabSat penetration, GDP per capita, the employment rate, population, and cell phone penetration. The penetration of many of these technologies (CabSat, Internet, and cell phone) is quite strongly related to average income. TV viewing, by way of contrast, is negatively related to income. Therefore, these newer technologies appear to be a form of "luxury" good in many places, whereas televisions appear to have become a necessity and since television viewing is negatively related to income, it might not seem surprising that television viewing is negatively related to these newer technologies. These univariate cross-sectional relationships may well give misleading results; however, so we now turn to multiple regression analysis.

Table 3 Correlation coefficients 2002 ($N = 48$)

	TV viewing	Internet	CabSat	GDP	Employment	Population
Internet penetration	−0.258	1				
CabSat penetration	−0.285	0.611	1			
GDP per capita	−0.247	0.841	0.559	1		
Employment %	−0.334	0.578	0.283	0.500	1	
Population	−0.217	−0.231	−0.029	−0.254	0.132	1
Cell phone penetration	−0.211	0.620	0.356	0.757	0.175	−0.417

5 The econometric model

Our main focus is to measure the extent to which an increase in variety of television programming affects television viewing, but we also seek to measure how Internet usage affects television viewing. A simple approach to studying these questions would be to use cross-sectional country-level variation in television viewing (T), variety of viewing choices (V), and Internet use (I), to estimate whether the daily average number of minutes of television per capita watched in country j in any given year

$$T_j = \alpha + \beta X_j + \phi V_j + \psi I_j + u_j \tag{1}$$

is correlated with the variety of viewing choices or with the daily average number of minutes of Internet use per capita in that year. In Model (1), X_j represents other covariates for country j and u_j represents the error, which accounts for the effect of unobservable variables on television viewing.

An important shortcoming of this approach is that variation in television viewing across countries may be related to factors that the limited control variables included in the model are unable to capture. Cross-sectional regressions estimate the effects of variety of viewing choices and Internet use on television viewing by comparing countries with low and high levels of variety and Internet use. But the levels of variety and Internet use are unlikely to be randomly assigned across countries conditional on our limited observables characteristics.

One solution is to use panel data variation. Panel data variation provides a far superior approach because it allows us to control for time-invariant country unobservable characteristics that may be correlated with the levels of both variety of viewing choices and Internet use, such as the availability of alternative entertainment options or social mores about television viewing. Panel data analysis also allows us to control for country-invariant time characteristics, such as whether the Olympics or World Cup is being televised or not.

The daily average number of minutes of television viewing per capita in country j and year t, T_{jt}, is represented by

$$T_{jt} = \alpha + \beta X_{jt} + \phi V_{jt} + \psi I_{jt} + \beta_t \text{dummy}_t + \beta_j \text{dummy}_j + u_{jt} \tag{2}$$

where α is a constant, X_{jt} is a set of variables with time variation within countries, β_t is a time t fixed effect (a year fixed effect which is common for all countries),

dummy_t is an indicator variable equal to 1 in time t, β_j represents a country-specific and time-invariant effect, dummy_j is an indicator variable equal to 1 for country j, ϕ represents the effect of increases in variety on the average number of minutes of television viewing in that country, ψ measures the effect of changing the average number of minutes of Internet use in a country on television viewing and u_{jt} is the error. Country fixed effects absorb the effect of unobserved time-invariant factors specific to each country. For example, religious composition and wealth inequality at the country level are unlikely to change substantially over our study period. Using a longitudinal model, we can "difference out" all the time-invariant unobserved characteristics at the country level. Because Model (2) includes time fixed effects, identification arises from idiosyncratic variation in variety, Internet penetration, and television viewing from year to year rather than aggregate global trends in programming variety, Internet penetration, and television viewing over time.

We do not observe (or even know the proper metric for) program variety. Nevertheless, we believe it is reasonable as an approximation to assume that average product variety is directly related to the share of the population using cable or satellite (the CabSat variable)

$$V_{jt} = b\text{CabSat}_{jt} \tag{3}$$

Internet usage has increased significantly since the birth of web browsing. This is both because more people use the Internet and because Internet users spend more time online. We do not observe the average time use of the Internet at the country level, but we do observe the level of Internet penetration. We propose a linear relationship between the number of minutes of Internet use and Internet penetration as an approximation, P_{jt}:

$$I_{jt} = aP_{jt} \tag{4}$$

Substituting (3) and (4) into (1) and (2), we get:

$$T_j = \alpha + \beta X_j + \phi b\text{CabSat}_j + \psi\, aP_j + u_j \tag{1'}$$

and

$$T_{jt} = \alpha + \beta X_{jt} + \phi b\text{CabSat}_{jt} + \psi aP_{jt} + \beta_t\text{dummy}_t + \beta_j\text{dummy}_j + u_{jt} \tag{2'}$$

where the term ϕb indicates the impact of an increase in CabSat on television viewing and ψa indicates the impact of an increase in Internet penetration on television viewing.

Models (1′) and (2′) are the econometric models we use in the following section. In some panel data regressions, we will also include country-specific time trends (see Wooldridge 2010, pp. 375). It is likely that unobserved idiosyncratic trends in technology adoption occurring during the study period are correlated both with idiosyncratic trends in cable and satellite penetration and with Internet adoption. For example, we do not observe the rate of video games console adoption at the country level, although these trends might influence television viewing and be correlated with idiosyncratic trends in the adoption of both cable and satellite and Internet. In a random trend fixed effect model, country-specific time trends may account for unobservable idiosyncratic trends. Including the term $\delta_j t$ in ($2'$), where t is a time trend, allows the study of the impact of increasing the penetration of both cable and satellite and Internet on television viewing controlling for country-specific time trends.

Idiosyncratic time trends can also help in the identification of population-averaged coefficients in random-coefficient models [when the slopes in ($2'$) are heterogeneous across countries, which may be the case if a and b in (3) and (4) vary by country]. Wooldridge (2005) shows that "the fixed effects estimator that sweeps away individual-specific trends is satisfyingly robust to the presence of individual-specific slopes on the individual-specific covariates."

Besides the assumptions we have already made, there are other possible complications with this analysis. The rapid evolution of the Internet since the birth of the World Wide Web, in terms of the quality and quantity of both entertainment and productivity offerings, means that the impact of the Internet on television viewing may not be consistent over time. For example, as connection speeds increase and the quality and variety of Internet Web sites increase, it is unclear whether individuals will increase or decrease their time spent using the Internet since they can accomplish each activity in less time, but there are also more activities in which they are likely to be interested. Further, if early adopters of the Internet have different (entertainment) uses for it than later adopters, the impact of the Internet on television viewing may change over time merely due to the nature of the new Internet adopters relative to the old adopters.

Finally, every Internet user also must have access to a computer. Although not every computer user has Internet access, Internet access will be closely associated with computer use. If computers were altering the entertainment habits of individuals separately from the impact of the Internet, we would not be able to separate out the two and would tend to attribute to the Internet the possibly independent impact of computer usage. Because it appears that the Internet has tended to dominate the entertainment uses of computers; however, we do not consider this to be an important problem.[16]

6 Estimation results

Although we use panel data with both year and country fixed effects, we begin our regression analysis with an examination of the pooled data with and without year fixed effects and then extend the analysis to both year and country fixed effects.

6.1 Pooled regressions and year fixed effects

The results of the pooled regressions and including year fixed effects are presented in Table 4. The simple pooled results indicate a small negative impact of CabSat

[16] Computer-based videogames are a well-known form of computer entertainment but have always been dwarfed by videogame consoles (see yearly reports from the Entertainment Software Association).

Table 4 Pooled and year fixed effects regressions results on TV viewing

	Pooled year regressions	Fixed effects regressions
CabSat penetration	−0.1957	−0.211
	(0.1275)	(0.1274)
Internet penetration	0.2711	−0.1384
	(0.2324)	(0.2621)
GDP per capita	−1.0238*	0.0705
	(0.6116)	(0.8697)
Percentage employment	−1.2798*	−1.1342*
	(0.6419)	(0.6343)
Population	−0.0247	−0.044
	(0.0328)	(0.0296)
Cell phone penetration	0.0642	−0.276
	(0.1491)	(0.1957)
Constant	284.71***	319.99***
	(33.48)	(34.75)
Observations	581	581
R^2	0.1934	0.2473

Robust and clustered by country standard errors in parentheses

* Significant at 10 %; ** significant at 5 %; *** significant at 1 %

(viewing choice) on television viewing time and a still small but slightly larger negative impact when year fixed effects are included as covariates in the regression. The coefficient, approximately −0.2, indicates that an increase in CabSat penetration of 100 % points would decrease viewing by 20 min, which is only about 10 % of average viewing levels, so this is a small effect (more so considering that no country in the sample experienced such an increase in CabSat penetration). Neither of these regressions provides small enough standard errors to reach typical levels of statistical significance given the size of the coefficients although the confidence levels are not that far away. Internet usage (penetration), which could substitute for television viewing, has a small positive effect without year fixed effects and the smaller negative effect with year fixed effects. These coefficients are measured quite imprecisely.

The only other variable with consistent results and that is measured with sufficient precision to be interesting is the percentage of the population that is employed. It is negative in both cases, with a 10 % point increase in employment leading to a reduction in daily viewing of about 13 min.

We turn now to the more reliable full fixed effects regressions using the panel data.

6.2 Year and country fixed effects

Table 5 reports OLS for the full sample and also for the smaller balanced panel. We also have run the results with and without idiosyncratic time trends. As noted in

Table 5 Country and year fixed effects regressions results on TV viewing

	OLS regressions		OLS balanced panel	
CabSat penetration	−0.1016	0.0692	−0.0108	−0.1129
	(0.2318)	(0.2792)	(0.2701)	(0.3521)
Internet penetration	−0.0981	0.1851	−0.4610***	−0.1181
	(0.2858)	(0.1377)	(0.1337)	(0.1368)
GDP per capita	−0.9737	−2.0979	−4.3992***	−4.7150***
	(1.5864)	(2.2009)	(1.0269)	(1.4846)
Percentage employment	−0.6183	0.0925	0.3604	0.6416
	(0.8885)	(1.1406)	(0.7583)	(0.5580)
Population	−0.2925***	−11.3586	0.5699*	7.6653
	(0.0827)	(8.8271)	(0.2813)	(6.9274)
Cell phone penetration	0.0961	−0.0004	−0.1228	0.0103
	(0.1365)	(0.1169)	(0.1168)	(0.1683)
Constant	297.70***	731.00*	192.12***	−16.60
	(40.99)	(375.11)	(43.64)	(283.47)
Idiosyncratic trends	No	Yes	No	Yes
Observations	581	581	312	312
R^2	0.8275	0.9248	0.9438	0.9637

Robust and clustered by country standard errors in parentheses

* Significant at 10 %; ** significant at 5 %; *** significant at 1 %

Table 2, the sample of countries with viewing data is considerably lower in years prior to 2001. Therefore we deemed it useful to compare the CabSat coefficients for the consistent but considerably smaller sample of countries that had complete data for every year.

Our main variable of interest, CabSat, is essentially zero in the full OLS regressions, being slightly negative without idiosyncratic time trends but slightly positive with them. Given these small coefficients of opposing sign, we conclude that increases in viewing choices as measured by CabSat are not related to changes in television viewing. A similar result holds for the balanced panel, so we conclude that this lack of change in viewing in the presence of extra viewing choices is not a byproduct of having an unbalanced panel.[17]

Further, there is an important potential endogeneity problem that can arise when comparing viewing and CabSat penetration across individuals since those individuals with the greatest proclivity for watching television are also more likely

[17] We also checked for the possible impact of outliers. First, we ran Huber robust regressions (using a Stata routine that first eliminates observations with levels of Cook's D that are above a particular threshold and then iteratively lowers the weight for observations with large absolute residuals until a convergence threshold is reached). The Huber robust regressions had values of approximately −0.16 and appear to be statistically significant, but the inability to cluster observations in those calculations may bias the standard error. We also looked at the DfBetas of the OLS CabSat variable but did not find any support for the more negative results indicated by the Huber Robust regressions. Similarly, we found that quantile regressions provided results much closer to the OLS regression than the Huber Robust results and thus feel that the OLS results are likely to be more reliable for this important variable.

to subscribe to CabSat services. So, for example, in numerous studies where viewing habits of CabSat subscribers have been compared to viewing habits of non-subscribers, it has been the case that CabSat subscribers watch considerably more television, but this might have been due to their interest in television and not due to the impacts of CabSat. Our use of fixed effect regressions on country-level data circumvents this problem, however, since the estimates from these models are identified from comparing entire populations over time, and overall viewing within a country will not be altered by the introduction or growth of CabSat if CabSat merely attracts the viewers with the greatest proclivity for viewing and does not actually change viewing behavior. Moreover, as we argued before, television penetration was at already high levels in the beginning of our study period and therefore our television viewing data represent almost the entire population in each country.

Our next variable of interest is the extent to which the Internet, as a substitute entertainment activity, is related to television viewing.[18] The full sample OLS results provide coefficients that are small, with the sign of the coefficients differing depending on whether idiosyncratic time trends are included or not. Liebowitz and Zentner (2012) found, using data on American television viewing, a negative impact of Internet penetration on television viewing of about 10 % for an Internet penetration rate of 70 % (an increase in Internet penetration from 0 to 70 %). The current zero results might seem to indicate that the effect of the Internet as an entertainment substitute for television is weaker in an international context.

The balanced panel, however, tells a different story of the relationship between Internet usage and television viewing and one that is more consistent with Liebowitz and Zentner (2012). The coefficients are negative whether or not idiosyncratic time trends are included in the analysis. We can only have reasonable confidence that the coefficient is negative when time trends are not included, and in that case the coefficient leads to a result slightly larger than that of Liebowitz and Zentner (2012) since an increase in Internet penetration of 70 % points would lead to a viewing decline of 31.5 min, or approximately 15 %. The coefficient with a time trend, although we cannot have much statistical confidence in it, would imply that the Internet lowered viewing by about 4 %. These two coefficients, from the balanced panel, bracket the results of Liebowitz and Zentner (2012). It is possible, therefore, that the unbalanced aspect of the full panel has skewed the results away from a finding that the Internet was a substitute form of entertainment during the period of our analysis. There is some evidence to support this supposition since income for countries in the balanced panel is approximately 30 % higher than that for countries that have incomplete data. This implies that those countries in the balance panel are more like the USA, at least in terms of income, and higher income countries seem more likely to have the internet act as a form of alternative entertainment, an intuitively plausible result.

[18] A related but different question is the study of the extent to which watching television shows on the Internet (e.g., YouTube) displaces conventional television viewing. Waldfogel (2010) studies this question and finds evidence of modest substitution between the two outlets.

Finally, we have the results for the more incidental variables. The full panel regressions indicate that income has a negative relationship to viewing, but we cannot have much confidence in this result because of the relatively large standard errors. The balanced panel (with its higher average income) tells a much stronger story, however. For the balanced panel, income has a negative relationship with viewing that is both economically and statistically significant. An increase in income per capita of 50 % (~$13,000 using the 2008 average values for the balanced panel) would be expected to decrease television viewing by about 58 min, or about 30 %, everything else constant. The imprecise full panel estimates are less than half of this.

The relationship between the percentage of the population employed and television viewing is basically nonexistent according to the regression results. The coefficients in the various samples are all imprecisely measured and have disparate signs. Even if we picked a particular sample and specification and only focused on the coefficient, the seemingly large absolute value of the coefficients will not lead to much of a change in viewing. That is because the employment rate has a very small variation over time, and the variation across countries is also very small (see Table 1). Therefore, even taking these coefficients at face value, the very small variations in employment rates that occur can only lead to very small changes in television viewing. For example, the average absolute value of changes in employment percentages over the 1996–2008 time period for our sample of countries is 4.6 % points, with a standard deviation of 2.8 % points. Thus, a change of two standard deviations in the percentage employed would only change viewing by <4 min (using a coefficient of 0.65 to match the largest coefficient in Table 5) and even the largest change in the percentage of workers employed in any country (Romania's 12.2 % points change) would change viewing by <8 min.

The full fixed effects regressions all imply that cell phone penetration is irrelevant to television viewing. This result fits with our intuition that cell phone usage should not be related to television viewing during our period of analysis.

Finally, the coefficients on population require some discussion. Because the country fixed effects soak up the cross-country population variation and the year fixed effects soak up the aggregate time trend, the population variable measures whether a country has an expanding or contracting population relative to the mean population change. Further including idiosyncratic time trends strips all meaning from the population variable; when idiosyncratic trends are added to the list of covariates, the coefficient on population is not identifiable because all the variation in the population variable is captured by the other covariates in the regressions.[19] For this reason, it is not surprising that when idiosyncratic trends are included, the standard errors on the population coefficients are very large and the sizes are highly variable.

We therefore analyze the effect of population on television viewing concentrating on the regressions without country-specific trends. The results from the balanced

[19] The R^2 of a regression using population as dependent variable and all covariates as independent variables is one (including in the list of covariates an individual trend for each country). This demonstrates that the population variable provides no additional information once the rest of the covariates are included in the regressions.

panel indicate that countries with growing populations tend to have a greater amount of television viewing. The opposite is true for the entire sample. This is something of a puzzle, although it was unclear a priori, what to expect from this variable. Population growth means a smaller share of old individuals and these individuals tend to watch the most television, at least in most Western countries, which might lead to a negative sign. Although large populations might make more production of television programs possible, this may be more likely for advanced economics than for less advanced economies. Although we can provide some rationales, we do not claim to have a clear understanding of the sign reversal.

7 Strategic implications for firms

Our empirical results suggest that greater choice derived from cable and satellite transmission did not cause viewers to spend more time watching television. One central question is whether the increase in variety that will be brought about by the celestial TiVo is similar enough to the increase brought about by cable and satellite for the latter to help foretell the impact of Internet-induced increased variety on the amount of television viewing. There are several reasons we believe that it is.

First, we believe that the additional programs carried on cable and satellite were intentionally provided to help fill previously unmet or poorly met tastes in the variety space. Because cable and satellite operators choose the programming they carry, they should not fall into Hotelling's trap of having networks "back to back" in product space, something that might occur when the creators of individual programs or networks, instead of cable providers, decide where to locate in the product space. Second, it is clear that the average distance between consumers' ideal program characteristics and the closest actual alternatives will diminish as new programs are provided by CabSat operators trying to match programs to consumer tastes.

The movement from broadcast television's handful of channels to cable TV's hundreds of channels is likely to have placed many viewers closer to their viewing preferences. Several hundred programs (at one time) from many different genres provide considerably more choice than two or three broadcast channels that cannot even cover all the main genres, and which are potential prisoners to Hotelling's inefficiency.

We acknowledge that the movement from CabSat to the celestial TiVo allows an enormous increase in the number of programs available at any one time. Nevertheless, for our empirical results to provide clues about the celestial TiVo merely requires that the Internet cannot reduce the distance from ideal to actual programs by so much more than CabSat did so as to make the examination of CabSat irrelevant.

One potentially confounding factor in using the results from CabSat as a predictor of the Internet's impact is portability. Because of portable laptops and even more so because of cell phones with Internet access, the Internet's increased variety is also linked with extra portability of viewing, although they are technically separate factors. Portability is not new in television viewing, however. Portable

DVD players and televisions have been available for a decade, but neither has become very popular. If cell phones and Internet access increased portability relative to prior market technologies, the celestial TiVo would likely increase television viewing for that reason, quite separately from the increase in programming variety.[20]

Nor do our results speak to the potentially confounding impact of piracy. The same advantages that Internet viewing of legitimate programs provide may increase the appeal of pirated programs, and if so, we would expect this to exacerbate the negative impact of audiovisual piracy that has been found in academic research (De Vany and Walls 2007; Hennig-Thurau et al. 2007; Rob and Waldfogel 2007; Zentner 2010).[21]

With these caveats in mind, some business implication of our results for sellers of television programming can be suggested. The pre-Internet business model has been a mixture of advertising and subscription, with over-the-air broadcasters using advertising and cable networks using both advertising and subscription fees (with a few subscription-only premier networks).[22]

Audience size and composition are the most important factors in generating advertising revenues. Additional viewing choices allow viewers to self-select according to tastes, and this segmentation might lead to more homogeneous viewers (in terms of their purchase intentions) for any potential advertiser. If so, advertisers will find it easier to match their ads to the interests of consumers, and advertising rates should rise. But these effects are likely to be second order in magnitude in the current circumstances since cable and satellite already provide substantial choice and self-selection in the viewing of very narrow television programs.

Subscription-based demand (whether streaming or unit purchases), by way of contrast, is strongly related to the value that viewers place on the programs they watch. Even if the celestial TiVo does not increase viewing time, it should increase the value that viewers receive from the programs they chose by allowing greater choice in programs and therefore increasing revenues for a given level of appropriability. This implies higher subscription prices.

Although it is sometimes claimed that Internet-distributed programming can be complements to traditional cable/satellite/broadcast television,[23] our results indicate that this will not be the case since total viewing does not appear to increase as more

[20] The value of portability in the case of music was examined in Liebowitz (2004) who found that the steepest increase in album sales occurred in the same years that had the greatest yearly increase in portable penetration.

[21] Although Smith and Telang (2009) find that free television broadcasts do not decrease demand for older movies, this seems likely to be due to the publicity effect of the broadcast overwhelming the substitution effect of the broadcast.

[22] It should also be noted that over-the-air broadcasters did not voluntarily forgo subscriptions but instead did not have a technological option for directly charging viewers.

[23] For example, a recent news article in the Toronto Globe and Mail quotes an industry executive thusly: "But it is important, I think, to remember that video consumption is not a zero-sum game. We believe that there is virtually an insatiable appetite for consumers to consume more media on a multitude of platforms…our belief is that new competitors will prove to be additive to the system as opposed to serving to carve up the pie."

choice is made available. The changes brought about by a shift to viewing over portable devices, however, may increase overall viewing.

Our results indicate that the growth in revenues for this industry due to the movement to the Internet (ignoring the portability issue) is more likely to come from the subscription component relative to the advertising component of video programming.

8 Conclusions

Our goal in this paper was to examine how an increase in viewing choice brought about by using the Internet as the distribution media for television programs is likely to affect viewers, content owners, and broadcasters. Our approach has been to look at how changes in viewing choice due to the increased penetration of cable and satellite television transmission were related to changes in the amount of time consumers spent viewing television programs for a large panel of countries.

Our main result indicates that increases in program variety, beyond the variety available over-the-air, were not related to increases in viewing. This result was fairly robust relative to various regression specifications or sample selections. Although this result might appear to be surprising, it is not. First, economic theory has an ambiguous predicted relationship between viewing time and viewing choice. Second, an older literature that had looked at this issue, admittedly using less robust statistical techniques, had found only a small positive impact of variety on viewing, and that literature had examined the impact of greater choice starting from very low initial levels of choice.

Our results imply that the variety increase caused by the transition to the celestial TiVo might be a zero-sum game in terms of advertising because advertising is highly correlated with audience size. On the other hand, consumers should have an increased willingness to pay for the greater variety of programming on the Internet and this should allow broadcasters to benefit from the switch to the Internet if broadcasters adopt the correct business models.

Our findings are subject to all the usual caveats found in empirical work. Given that society is about to undergo a major transition in television viewing as the “transmission” switches to the Internet, further research is called for to help us gauge the future of the most popular entertainment activity in the world.

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Data Appendix: Television viewing, cable and satellite penetration, internet penetration, cell phone penetration, and demographics

We acquired data on television viewing by country for the years 1996–2008 from Mediametrie–Eurodata TV Worldwide, a company that collects information from national-level companies measuring TV viewing using mainly electronic devices (various types of meters). In all we have data for 52 countries although the panel is unbalanced (many countries do not have complete data for all the years). The countries are as follows: Argentina, Armenia, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, China, Croatia, Cyprus, the Czech Republic, Denmark, Egypt, Estonia, Finland, France, Georgia, Germany, Greece, Hong Kong, Hungary, India, Ireland, Israel, Italy, Japan, Latvia, Lebanon, Lithuania, Mexico, Moldova, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia, Serbia, Singapore, the Slovak Republic, Slovenia, South Africa, Spain, Sweden, Switzerland, the UK, the USA, Turkey, and Ukraine.[24] Data for Belgium are separated for French and Flemish communities, and data for Switzerland are separated for German, French, and Italian communities. There are a total of 55 regional markets after adding countries and communities.

Our data on cable and satellite penetration are from IHS Screen Digest. Screen Digest collects separate data for cable and satellite; we combined the two variables and created a variable called “CabSat” that measures the sum of the household penetration rates of cable and satellite.

Data on Internet penetration by countries are from the International Telecommunication Union (ITU), a United Nations agency for information and communication technology issues. The Internet penetration variable that we use measures the percentage of Internet users in the total population and includes Internet access from any device (e.g., mobile phones—although it should be noted that the iPhone was only introduced in 2007 in the USA and in 2008 in Europe).[25]

We also obtained data on cell phone penetration by countries from the ITU. The variable that we use measures the mobile cellular subscriptions penetration rate. The cell phone penetration rate has been over 100 % in recent years for several countries. The explanation for a penetration rate over 100 % is that this variable includes prepaid cell phones subscriptions; and prepaid cell phone lines retain their status for 3 months after the expiration of their card while these lines are still able to receive calls. Prepaid cell phones are popular in many European countries and some individuals replace their cell phone lines several times in any given year.[26]

The measure of income that we use is constructed using data from the International Monetary Fund World Economic Outlook Database, and following the guidelines proposed in the IMF discussion forum. The GDP per capita (normalized to the US dollar), called GDP PPP, accounts for the prices of goods and services in each country, and is an accepted measurement for comparing the level of development of different countries at any given time. However, the GDP in PPP values does not measure income in constant values and is therefore not appropriate for comparisons across time. A measurement of the level of development that makes the comparison of development levels across countries and across time feasible is constructed by combining the GDP in PPP values for a base year (we use 2000) and

[24] With the exception of Australia and Japan, the data measure television viewing at the national level. The data for Australia measure television viewing from the top five largest metropolitan Areas. The data from Japan measure the viewing from the Kanto region (this region includes the city of Tokyo).

[25] These data are readily available at http://www.itu.int/net4/itu-d/icteye/.

[26] See Footnote 25.

growth rates of GDP in local currency in constant values. A GDP measurement for each country and each year is constructed by multiplying the GDP in PPP US dollar values in the base year by the yearly growth rates of the GDP measured in local currency and constant values.

Finally, the measure of employment that we use is the percentage of the population older than 14 years that are employed. These data are from the World Bank.

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