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ABSTRACT

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We exploit supply-driven heterogeneity in the expansion of cable television across Norwegian municipalities to identify developmental effects of commercial television exposure during childhood. We find that higher exposure to commercial television reduces cognitive ability and high school graduation rates for young men. The effects are largest for exposure during pre-school and elementary school age. We find no effect on high school completion for women, suggesting availability of non-educational media content as a factor in the widening educational gender gap. Based on time-use data, we show that a possible explanation is that television-watching crowds out reading more for boys than girls.

JEL Classification: J13, J16, J24, L82

Keywords: human capital, media, education gender gap

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1 Introduction

Since television was introduced to a large audience around the mid-20th century, its effects have been debated. A widespread concern has been that television encourages a particularly passive form of engagement, and thus may be damaging to intellectual development. This view has been argued by social commentators (e.g. Postman, 1985), but has also received support in professional circles: American pediatricians have concluded that television affects children negatively, and recommend limiting children's television time (American Academy of Pediatrics, 2001; Strasburger, Jordan, and Donnerstein, 2010). The complete opposite view has also found supporters. Johnson (2006), for example, argues that popular culture, including television, has become more complex and intellectually demanding over time and that this gives beneficial cognitive payoffs.

Cognitive skills are essential for individual (Griliches and Mason, 1972; Cunha and Heckman, 2007) as well as aggregate economic outcomes (Hanushek and Woessmann, 2008). After a long period with generally rising IQ scores in industrialized countries, recent empirical evidence indicates that this development may now have gone into reverse; see Dutton and Lynn (2015) for a recent overview of the literature.[1] Since its introduction, television has spread all over the world; hence, its effects are also likely to be ubiquitous. If television viewing indeed can be harmful to the development of cognitive skills, this may be one explanation why IQ scores have stagnated or even started to decline in many countries. If so, this is critical knowledge for policy makers and families alike.

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[1] Recent negative trends in IQ scores have been reported for Norway (Sundet, Burlaug, and Torjussen, 2004), Australia (Cotton et al., 2005), Denmark (Teasdale and Owen, 2008), Britain (Shayer, Ginsburg, and Coe, 2007), Sweden (Ronnlund et al., 2013), the Netherlands (Woodeley and Meisenberg, 2013), Finland (Dutton and Lynn, 2013), and France (Dutton and Lynn, 2015).

The existing empirical evidence is not conclusive, however. In a review of the pediatrics literature, Jolin and Weller (2011) point out that statistical evaluations are often based on cross-sectional data, and they lament the lack of longitudinal research designs. There are some experimental studies focusing on short-term impacts, but the external validity of such studies is questionable; see Thakkar, Garrison Christiakis, (2006) for a review. An influential study within the economics literature is Gentzkow and Shapiro (2008), who analyze the effect of the introduction of television in the US in the 1940s and 1950s on standardized test scores. They find that, contrary to popular worries, television exposure during pre-school age not only failed to lower test scores, but in fact raised reading and general knowledge scores for socially disadvantaged groups. On the basis of this effect heterogeneity, they conclude that "the cognitive effects of television exposure depend critically on the educational value of the alternative activities that it crowds out (p. 282)." As most societies have undergone large changes in their educational and home environments since the early post-war era, this makes it pertinent to reexamine the issue. The impacts of television exposure also clearly depend on the contents of the programs that children are exposed to. Kearney and Levine (2015) examine the effects of the introduction of an explicitly educational children's show – Sesame Street – into a television programming space dominated by entertainment shows. They find support for the positive educational effect of Sesame Street, in particular for boys and children from disadvantaged backgrounds.

In this paper, we examine how a geographically staggered expansion of access to commercial cable television in Norway during the 1980s and 1990s affected children's cognitive skill developments and subsequent high school graduation rates. As we explain in more detail below, the introduction of cable television in Norway had huge impacts both on children's overall exposure to television and on the type of programs they watched. Whereas the state broadcaster, which held a legal monopoly on television broadcasts until 1981, offered

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a single TV channel only, based on a clear educational mandate, the new commercial channels were almost entirely dominated by light entertainment without any educational content. We provide empirical support for the view that the expansion of commercial cable television indeed had negative effects on men's cognitive skills – as measured by intelligence test scores at time of military service enrolment – and that it also reduced their high school completion rates. For women, we find no effects on high school completion rates. Data on intelligence test scores exist only for men.

When television was deregulated in Norway in the beginning of the 1980s, it became legal to forward television signals broadcast by satellites in local cable networks, and a large rollout of cable networks was initiated. We argue that the growth in cable networks was a supply-led development driven by geographical factors and settlement patterns, and the key explanatory variable in our analysis is the time-varying cable television coverage rate at the municipality level. Because residence decisions may be endogenous to cable television coverage, we use the future coverage in an individual's municipality of birth to instrument for his or her actual exposure. To account for unobservable factors possibly related to both television adoption and outcomes, we include in our regressions a wide range of region-by-year and other controls, including also municipality fixed effects and time-varying socio-economic variables at the municipality level. Further, due to the richness of our data, we are able to control for relevant parental characteristics in order to improve precision and account for possible selection.

Our results indicate that one year of living in a municipality with full coverage of cable television during childhood and adolescence lowers ability test scores of young men by 0.53 % standard deviations, corresponding to 0.08 IQ points. It reduces the high-school completion rate for males by 0.33 percentage points. These effects seem to be driven by consumption of light television entertainment crowding out more cognitively stimulating activities such as reading. The negative impacts of commercial television access are largest during elementary

school age. For women, we do not find convincing evidence of a negative effect on high school completion, thus a net effect was to widen the educational gender gap. A policy lesson regarding all forms of media that provide content with low educational value is that although consumption of such content is not necessarily harmful in itself, one should be alert about what activities it substitutes for, in particular for boys.

Our paper adds to a rapidly growing literature in economics on the effects of media. Television in particular has been found to impact outcomes as diverse as voter turnout in the US (Gentzkow, 2006), party choice in the US and Russia (DellaVigna and Kaplan, 2007; Enikolopov, Petrova, and Zhuravskaya, 2011; Martin and Yurukoglu, 2014), social capital in Indonesia (Olken, 2009), fertility, women's status and school enrollment in India (Jensen and Oster, 2009), and divorce and fertility in Brazil (Chong and Ferrara, 2009; La Ferrara, Chong, and Duryea, 2012).

Our study also adds to the literature on the educational gender gap. In most developed nations, girls have higher high school graduation rates than boys (OECD, 2014). In the US, girls had in fact higher high school graduation rates than boys for the most part of the twentieth century (Goldin and Katz, 2008); however from the 1970 the gap has widened (Murnane, 2013). In the same period, girls also made gains relative to boys on standardized math and reading tests (Goldin, Katz, and Kuziemko, 2006; Cho, 2007) and grades (Fortin, Oreopoulos, and Phipps, 2015). Previous research has found evidence that boys are more sensitive than girls with respect to both parental (Bertrand and Pan, 2013; Riphahn and Schwientek, 2015) and school/preschool inputs (Krueger, 1999; Machin and McNally, 2008; Chetty et al., 2011; Havnes and Mogstad, 2011). This is supported by evidence showing that boys benefit more strongly than girls from early childhood interventions (Campbell et al., 2014; Conti, Heckman, and Pinto, 2015) and are more impatient (Bettinger and Slonim, 2007;

Dohmen, Falk, and Sunde, 2010; Castillo, Ferraro, Jordan, and Petrie, 2011; Golsteyn, Grönqvist, and Lindahl, 2014).

2 Data and institutional background

Television was introduced in Norway in the 1960s. Until 1981, the state-controlled Norwegian Broadcasting Corporation held a legal monopoly on broadcasting in the country, and for most Norwegians, only a single TV-channel was available. In December 1981, the newly elected government announced that 30 other agents would obtain broadcasting licenses the following year, thereby breaking the public monopoly. It then became legal to forward television signals broadcast by satellites in local cable networks. All such local cable networks had to register with the Post- and Telecommunications Authority. The legalization in 1981 initiated a large-scale roll-out of local cable networks. Because of economies of scale in laying the necessary cables, the roll-out took place primarily in densely populated areas (Norwegian Ministry of Culture, 1995). Mandatory registration continued until 2004, at which point 40 % of the population was covered. The aggregate evolution of the number of households covered is shown in Figure I.
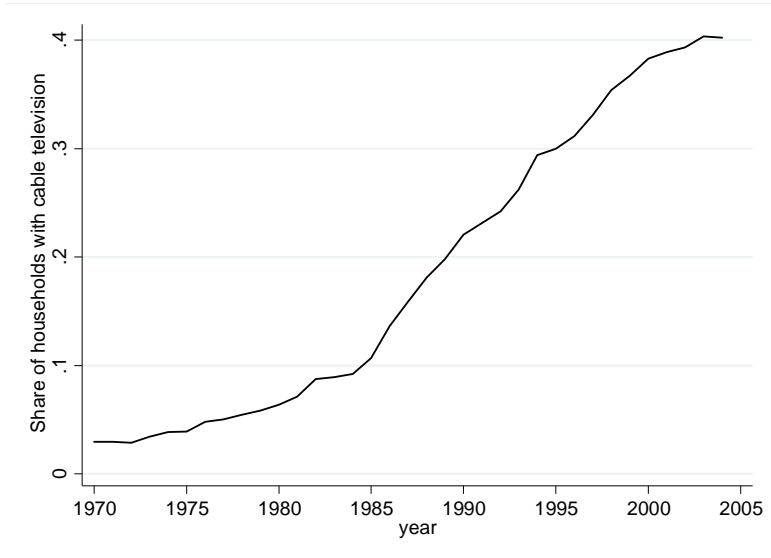
Figure I. Share of households with cable television 1970-2005

The television data consist of the universe of Norwegian local cable networks up to 2004. They contain more than 11,000 unique networks, each with the number of households covered, the first date of operation, and the municipality. We combine this with data on the number of households in a municipality to obtain the yearly coverage rate in each municipality up to 2005. The maps in Figure II show three snapshots of coverage rates across the country between 1985 and 2005. They illustrate the considerable geographical disparities in the roll-out process, with cable networks first established in the Oslo-area, and then expanded to other densely populated areas throughout the country. To arrive at individualized exposed-to-TV-variables, we construct two variables for each person born between 1974 and 1987: the cumulative cable TV coverage over their first 18 years both in their municipality of actual residence at any time and in their municipality of birth. The resultant TV coverage variables thus vary from zero (for individuals who never had access to cable TV before age 18) to 18 (for individuals who had access throughout their childhood and adolescence).
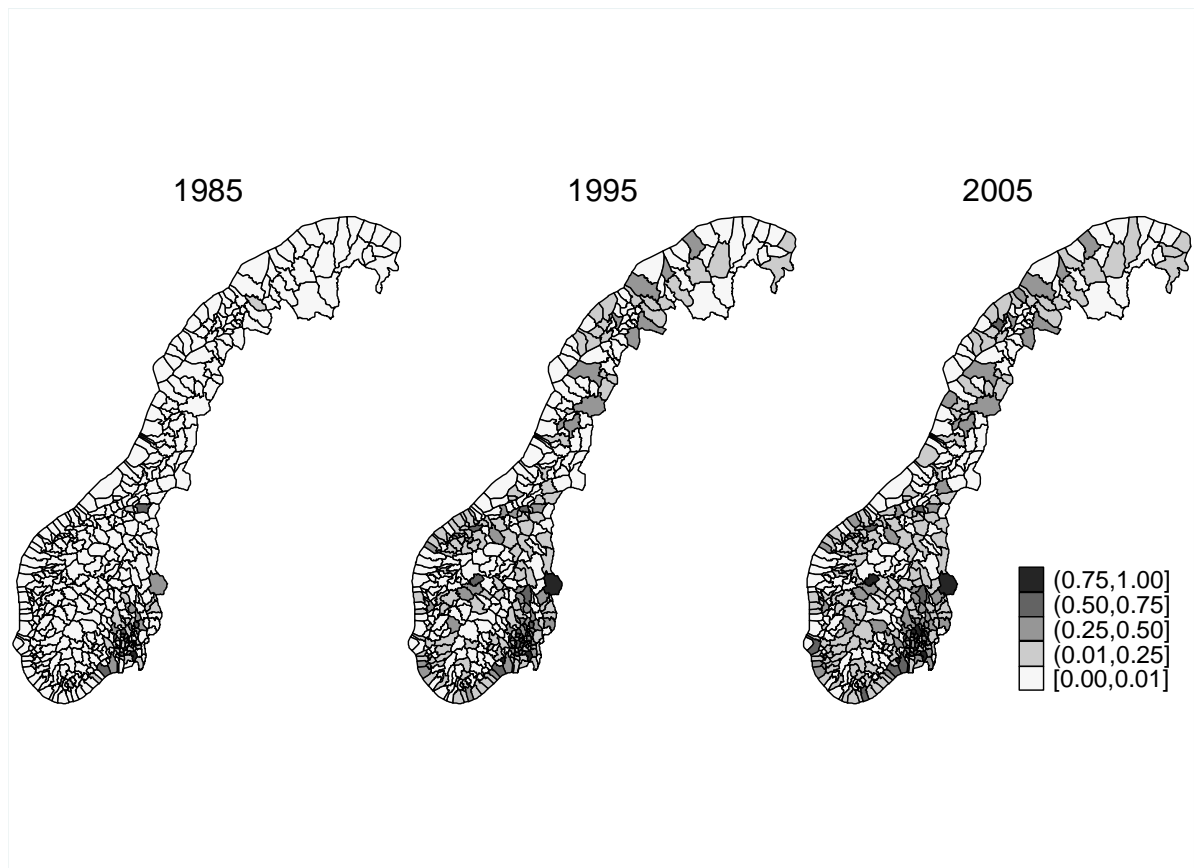
Figure II. Cable television coverage by municipality, 1985-2005

Unfortunately, we do not have the same kind of data on commercial television coverage by parabolic antennas. This is a minor problem in the present context, however, as parabolic antennas were providing only a small amount of television coverage in this period. When Statistics Norway started their media survey in 1991, only 5 % of the households had a parabolic antenna. Since parabolic antennas and cable television were substitutes for each other, the presence of parabolic antennas will nevertheless tend to attenuate our estimated effects of commercial television access slightly, as we implicitly will assume that cable networks are the only providers of these channels.

Coinciding with the expansion of commercial television in Norway, there has been a marked change in the way young people spend their leisure time. Figure III illustrates some key findings from a sequence of time use surveys provided by Statistics Norway.

Unsurprisingly, time spent watching television increased considerably for both boys and girls during the 1980s and 1990s. To a large extent, this substituted for reading, particularly among boys, for which time spent reading dropped by as much as 74 percent; from 39 minutes per day in 1980 to 10 minutes per day in 2000.
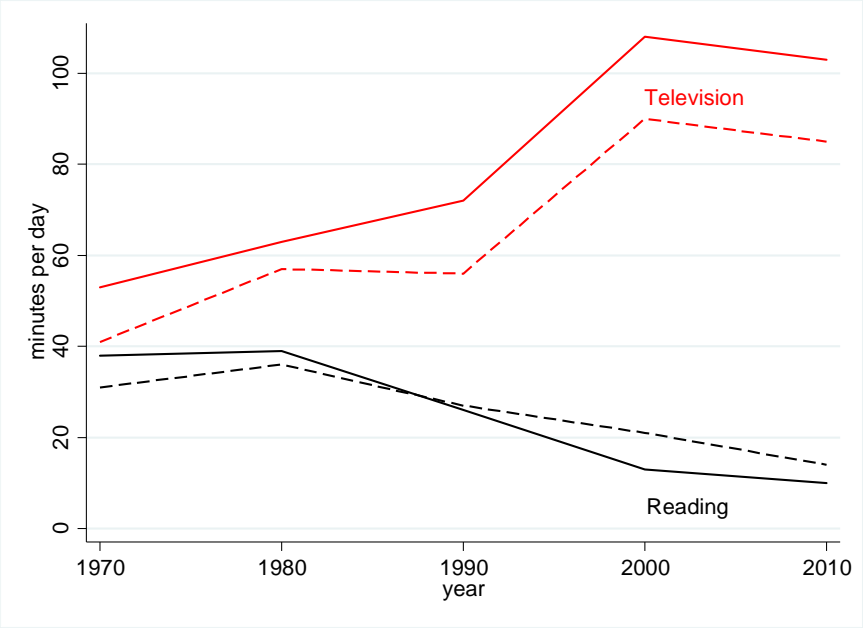
Figure III. Minutes Spent An Average Day On Television Wathcing and Reading, Boys (Solid Lines) and Girls (Dotted Lines) Aged 16-24.

Source: Statistics Norway; time use surveys collected in 1970, 1980, 1990, 2000, and 2010.

The data we use in the statistical analysis stem from different administrative registers, and cover the complete population. The outcomes we focus on are cognitive ability score at age 18 for young men, and a dichotomous variable indicating high-school completion by age 21 (two years after the "normal" graduation age) for both men and women. Our measure of cognitive ability is based on data from the Norwegian Armed Forces. Before compulsory military service, all Norwegian men undergo an assessment of suitability. From 1969/70, this assessment has included intelligence testing. All test-takers receive a score which is a composite of three tests, on arithmetic, word similarities and figures. In this paper we have standardized the test scores, thus point estimates will be directly interpretable as percentage

points of a standard deviation, though for expositional purposes we sometimes refer to the corresponding IQ scores.

Figure IV (left panel) shows that there has indeed been a negative development on this test since the early 1990s, in line with previous findings reported by Sundet, Burlaug, and Torjussen (2004). Another notable phenomenon was a widening of the gender gap in high school completion, which increased by more than 6 percentage points (right panel).
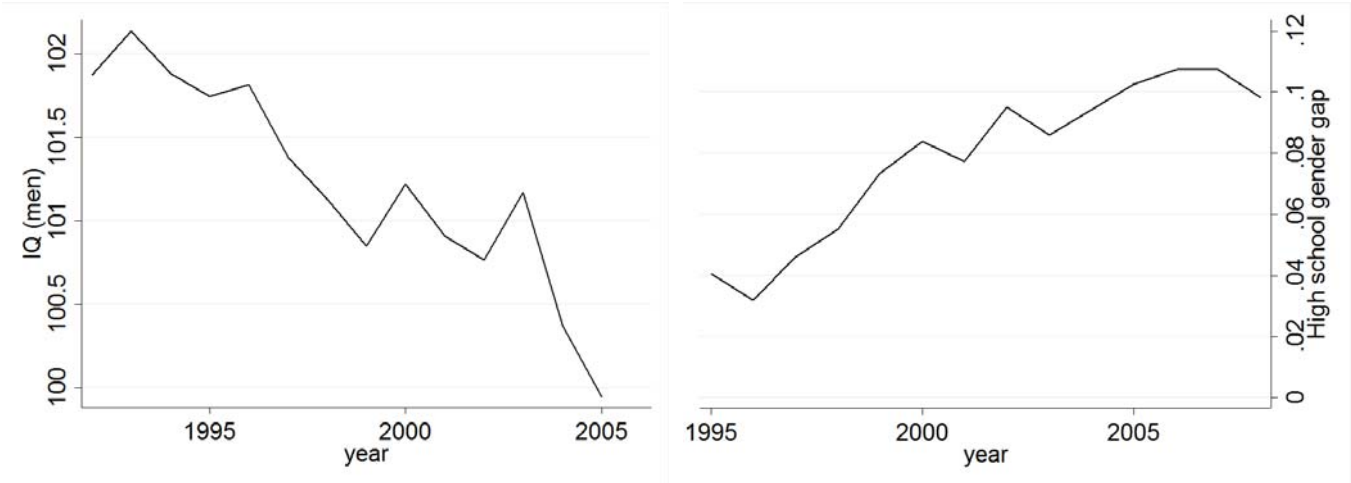
Figure IV

Left: IQ of Norwegian Conscripts 1992-2005.

Right: Female-male gender gap in high school completion at 21.

Note: The IQ test was normed on the test cohort of 1980, which provides the reference point (i.e. 1980 mean = 100).

We match the two outcomes with data on parental characteristics and on the municipality of residence from the year of birth and onwards. The first cohort in our sample is the cohort born in 1974, which is the first year from which we have data on residence at birth. We include all subsequent cohorts until and including the one born in 1987, which turned 18 years old in 2005. The reason why we stop at the 1987 birth cohort is that we do not have the data needed to compute total cable television coverage for later cohorts, as the mandatory registration of networks ended in 2004. To sum up, our sample consists of the birth cohorts

1974-1987, with outcomes measured in 1992-2005 (ability test scores) and 1995-2008 (high school completion). To allay worries concerning an increasing share of people with immigrant background taking the test, we include only individuals born in Norway to Norwegian-born parents.

Table I presents an overview of the data we use in this paper, with descriptive statistics for the two outcomes and for the various control variables we are going to use in the statistical analysis. In total, we have around 311,000 observations. On average, the persons in our dataset had access to cable TV in only 3.45 years during their childhood and youth. But TV exposure increased considerably over time, from less than 2 exposure-years for our first cohorts to more than 5 for our last (not shown in the table). The control variables are defined at the individual or at the municipality-by-cohort levels, in both cases measured no later than the time of birth. In addition, we will in some cases use municipality characteristics measured in 1980 (pre-legalization) interacted with time-indicators. Individual characteristics comprise the educational attainment and earnings levels of both parents, whereas municipality characteristics cover socio-economic factors, such as average education, employment, and earnings; see Table I for details.

Table I. Descriptive Statistics

	Boys		Girls		min	max
	mean	sd	mean	sd	min	max
Outcomes						
ability test score at age 18 (standardized)	0.08	(0.87)			-2.00	2.00
high school completed at age 21	0.67	(0.47)	0.75	(0.47)	0.00	1.00
Main explanatory variable						
TV, actual years of coverage until age 18 (municipality of residence)	3.31	(3.54)	3.29	(3.52)	0.00	18.00
TV, potential years of coverage until age 18 (birth municipality)	3.45	(3.70)	3.42	(3.69)	0.00	18.00
Controls						
Parental characteristics in birth year						
education father, four levels	1.98	(0.83)	1.98	(0.82)	1.00	4.00
education mother, four levels	1.83	(0.73)	1.83	(0.73)	1.00	4.00
income father, 1000 USD	69.11	(30.44)	69.09	(30.47)	0.00	259.09
income mother, 1000 USD	20.94	(22.87)	20.76	(22.83)	0.00	259.09
Municipality characteristics in birth year						
schoolyears attained	11.45	(0.44)	11.44	(0.44)	8.90	12.84
income males, 1000 USD	62.57	(8.17)	62.54	(8.15)	31.39	88.98
income females, 1000 USD	25.52	(7.30)	24.46	(7.28)	6.58	45.94
employment rate males	0.80	(0.04)	0.80	(0.04)	0.42	0.90
employment rate females	0.44	(0.12)	0.44	(0.12)	0.08	0.71
Municipality characteristics pre reform (1980)						
schoolyears attained 1980	11.45	(0.41)	11.45	(0.41)	10.14	12.63
income males 1980, 1000 USD	64.43	(7.28)	64.40	(7.26)	38.75	82.53
income females 1980, 1000 USD	25.88	(5.51)	25.85	(5.50)	12.72	37.48
employment rate males 1980	0.81	(0.03)	0.81	(0.03)	0.56	0.89
employment rate females 1980	0.45	(0.09)	0.45	(0.09)	0.18	0.62
population density 1980	0.69	(0.27)	0.69	(0.27)	0.00	0.99
average ability level 1980	-0.03	(0.19)	4.93	(0.18)	-0.68	0.43
Observations	310430		293643			

Note: Parental education in four levels (less than high school, completed high school, university bachelor, university master); income is yearly earnings measured in 2013 prices, converted to USD with an exchange rate of 1 USD=6.5 NOK and right-censored at 20 times the "basic amount" used by the Norwegian Social Insurance Scheme; all municipality level covariates are based on inhabitants with Norwegian-born parents; municipality level income and employment are calculated based on inhabitants aged 18-60; in calculating employment rates, we count as employed individuals with yearly earnings at least 2 times the basic amount, corresponding to around USD 26 000; population density is defined as the share of the municipality inhabitants living in a "densely populated" area.

3 Empirical strategy

In order to identify the causal impacts of cable network expansion on the ability test score and schooling outcomes, we use the municipality-by-cohort specific coverage rate described in Section 2 as the key explanatory variable. The identifying assumption is then that the geographical rollout of cable TV was as good as randomly assigned with respect to other factors that could have generated local variations in the developments of cognitive ability and high school completion rates, conditional on the control variables we use in the analysis. We argue that we can rule out reverse causation in this case, as there is evidence that the cable network expansion during the 1980s and 1990s was solely supply side driven. Building cable networks required heavy investment in infrastructure, and was only profitable in densely populated areas. Given that there was a large excess demand for cable TV everywhere, the actual expansion pattern was determined by economies of scale and physical/topological constraints. Participants from the supply side of the cable television market in this period have confirmed that it is hard to see any factors other than suppliers' capacity and population density that had an impact on where networks were built, and that the deregulation suddenly allowed suppliers to cater to a demand that had been present for a long time.[2] Further evidence for the exogeneity of coverage comes from considering the size and distribution of the networks. Many networks in a locality were constructed at the same time as parts of the same development. The average number of new households gaining access conditional on expansion in any given municipality-year, which is our observational unit, is 691. Thus it is clear that access was determined at a quite different level than the household. The fact that cable networks did not operate in almost 40 % of municipalities (163 of 430) also shows that whether to obtain access was clearly not an individual-level decision.

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[2] Former head of the union of commercial cable-TV operators in Norway, Knut Børmer; personal communication. Terje Frøsland, of the state owned *Norwegian Telecommunications (Televerket, from 2005 Telenor)*; personal communication.

In 1999, a government White paper concluded that "significant development of cable networks beyond today's level will most likely not be profitable (Norwegian Ministry of Culture, 1999, Ch. 2.2)," and that "one does not expect significant further development of cable utilities beyond today's coverage of around 38 % (Norwegian Ministry of Culture, 1999, Ch. 2.3)." From Figure 1 we see that this assessment proved correct. The report cites topographical and physical barriers as reasons for why full coverage would not be possible.

As an empirical check on the supply-driven expansion pattern, we run a regression where we use the potential years of coverage (in the municipality of birth) as the dependent variable and a number of pre-expansion (1980) municipality characteristics as explanatory variables. As can be seen from the results reported in Table II, the only variable that is related to subsequent cable television expansion in a statistically significant way is population density.

Table II

TV Exposure in Birth Municipality as Dependent Variable. Regression Results.

	(1) Cable TV coverage, years
<u>Baseline municipality characteristics</u>	
Average schoolyears 1980	1.61
	(1.10)
Average income males 1980	0.09
1000 USD	(0.07)
Average income females 1980,	-0.23
1000 USD	(0.35)
Employment rate males 1980	-9.54
	(8.62)
Employment rate females 1980	16.35
	(19.05)
Average male ability 1980	0.57
	(1.07)
Population density 1980	3.38
	(1.36)
	**
cohort f.e.	Yes
ymean	3.44
N obs	604073
N municipalities	430

Note: Relation between cable television expansion and municipality covariates in 1980. Standard errors clustered on municipality. Standard errors in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Although demand did not play a significant role for the rollout of cable TV in Norway, we cannot a priori rule out that the (typically densely populated) areas selected for early expansion have been characterized by different developments in ability scores and schooling outcomes than other areas for reasons unrelated to the cable television expansion. Hence, as we detail below, an important element of our empirical strategy is to control for other possible geographically differentiated trends.

To empirically assess the impacts of cable TV coverage, we use linear regression models with the two outcomes (cognitive ability score and a dichotomous indicator for high school completion) as dependent variables and the number of years with cable TV coverage until age

18 as the central explanatory variable. Although we have argued that individuals were unable to influence the geographical pattern of cable television expansion, they could obviously ensure own access by migrating to a place with coverage. Hence, the *actual* municipality of residence is potentially endogenous. We will apply instrumental variables models to deal with this problem; i.e., we use the cumulative television coverage in an individual's municipality of birth over the same 18 years to instrument for actual coverage.

It may be argued that the ability test score is an ill-defined dependent variable in a linear regression framework, as the test score scale in principle is ordinal. However, in practice, we have seen that the ability scores fit well into a cardinal interval scale in relation to important outcomes such as annual earnings. This is illustrated in Figure V, where we have plotted average (standardized) male labor earnings at age 40 against ability score (based on 2013 earnings data). The relationship between earnings and ability score is close to linear. Based on this relationship, we have also attempted to rescale the ability score used in Equation (1) such that it actually measures the predicted earnings level at age 40, and thus anchored the test score in an outcome of substantive economic interest. This made essentially no difference for the results, however; hence in the remaining of this paper, we focus on the results where we have used the ability test score directly as the left hand side variable.

Let *i* be a subscript for individuals, *m* for municipality of birth, *c* for county of birth, and *t* for year of birth. We can then write our baseline second step regression model (to be further explained below) as:

$$y_i = \beta \, \widehat{TV_a} + \delta_m + \Theta_{ct} + s_{mt}\zeta + p_i\eta + (m_0 \times I_t)\lambda + \varepsilon_{imt} \tag{1}$$

where y_i is an individual outcome measured at age 18 or age 21, $\widehat{TV_a}$ is predicted cumulative cable TV exposure during the first 18 living years, δ_m is a birth-municipality fixed effect, Θ_{ct} is a birth-county-birth-year fixed effects, (s_{mt}, p_t) are vectors of socioeconomic municipality characteristics at the year of birth and parental characteristics,

respectively, and $(m_0 \times I_t)$ is a vector of pre-reform (1980) birth-municipality characteristics (m_0) interacted with birth-year dummy variables (I_t). The predicted cable TV exposure is the linear prediction from a first stage equation where actual TV exposure (based on correctly assigned municipality in every year) is the left-hand side variable and the corresponding TV exposure in the municipality of birth is the right-hand side variable, together with the municipality and county specific controls included in (1).
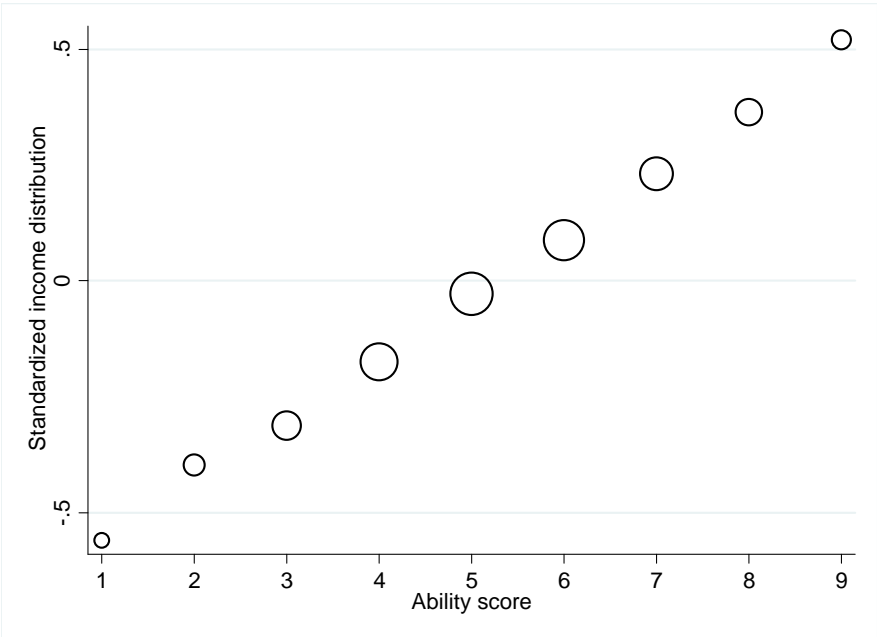
Figure V
Standardized income at age 40 by ability test score
Note: Data based on income of 40-year old men in 2013. Income is first averaged by ability score, then standardized.

An important point to note is that *all* the explanatory variables in (1) are predetermined at birth or earlier. The birth-municipality fixed effects are included to control for any time-invariant factors that vary between municipalities in a way that correlates with cable TV expansion. We can obviously not use municipality-year fixed effects, as that would totally absorb also the effects of interest. However, by including regional birth-year fixed effects at a somewhat higher geographical level, we can control for time variations that are common within regions. There are 19 counties in Norway, and each county covers approximately 23

municipalities on average. A somewhat unfortunate consequence of using county-year fixed effects is that we effectively throw out observations from Oslo, the capital city, which is by far the largest municipality and forms its own county. However, we exploit these data in a separate analysis, where we use observations from the largest cities/municipalities only (without county-year dummy variables).

The vector of time-varying socioeconomic municipality characteristics s_{mt} is included to account for local trends in observed cohort composition that potentially vary across municipalities. The vector includes municipality-level average education, male and female income, and male and female employment rates; see Table I for details. These are all measured in the year of each cohort's birth; hence, they are not absorbed by the municipality-fixed effects (which are common for all cohorts). The vector of parental characteristics p_{it} includes parental income and indicator variables corresponding to four different categories of completed education. As with the municipality covariates, the parental characteristics are measured in the year of birth of the individual. The interactions of the pre-reform (1980) municipal characteristics and a vector of birth-year dummy variables are included in the manner of Duflo (2001) to control for unobserved local trends in outcomes that vary systematically with factors which potentially influenced network expansion. Since population density was a particularly important factor behind the cable network expansion, we include the 1980 level of population density among the municipal characteristics in this exercise.[3] We also interact the municipalities' pre-reform (1980) average ability level among men with year of birth dummies in the same way in order to account for possible influences of mean-reversion tendencies in the data.

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[3] We have also estimated the model using a categorization of population density in deciles in this interaction in stead of using it directly as a scalar. This makes essentially no difference for the results.

4 Main results

The first stage and reduced form estimation results are reported in Table III. The first stage results show that there is a very high correlation between cable television coverage in the municipalities of actual residence and in the municipality of birth. The instrument is powerful. The three final columns show the reduced form effects, using our main model from equation (1) and cable television exposure in individuals' municipality of birth only. The results are a clear preview of what we are going to find later – negative effects for both cognitive ability and high school completion for men and zero effects for women.

Table IV presents our main estimation results in the form the second stage estimates for three alternative models, distinguished by different degrees of control for unobserved time trends interacted with pre-reform municipality characteristics. Note that all the models reported in Table IV contain municipality fixed effects as well as county-by-year fixed effects, in addition to parental characteristics and average municipality characteristics for each cohort. We consider these controls to be essential in order to isolate the presumed random-assignment-like variation in TV exposure, and thus disentangle the causal effects of interest from other potential sources of spatial variation in outcome developments. In the first row, we control for differential time developments correlated with pre-reform population density only, as this is the only variable we know for certain had a considerable impact the cable TV expansion pattern and, hence, represents the most likely source of omitted variable bias. In the second row, we add in the other pre-reform municipality characteristics, such as average education, income, and employment rates (see Table I). And in the final row we also add in the average pre-reform ability level among men. In all cases the pre-reform characteristics are interacted with birth-year dummy variables; hence there are no smooth-trend-assumptions involved in this exercise. Although each of the added variable

groups contributes significantly to explaining the outcomes, the estimated effects of cable TV exposure remain stable.

Table III

First Stage and Reduced Form Results

	First stage		Reduced form		
	Men	Women	Men		Women
	Actual exposure, years		Standardized Ability	High School Graduate	High School Graduate
Potential exposure, years	0.82	0.82	-0.0044	-0.0026	-0.0002
	(0.014)	(0.014)	(0.0024)	(0.0012)	(0.0012)
	***	***	*	**	
Aggregate fixed effects	Yes	Yes	Yes	Yes	Yes
Municipality covariates	Yes	Yes	Yes	Yes	Yes
Pre-reform characteristics # cohort fixed effects	Yes	Yes	Yes	Yes	Yes
Parental covariates	No	No	Yes	Yes	Yes
F(instrument)	3435	3444	3	5	0
N obs	310427	293641	279954	310427	293641
N muncipalities	430	430	430	430	430

Note: "Aggregate fixed effects" includes municipality fixed effects and county-year fixed effects. "Municipality covariates" includes average years of schooling attained, male and female income levels, male and female employment rates, all measured in the year of birth. "Pre-reform characteristics" includes 1980 levels of the share of the municipality inhabitants living in a "densely populated" area, the municipality covariates, and average ability score of men residing in the municipality. "Parental covariates" includes education level fixed effects and income for both parents, all measured in the year of birth. Standard errors clustered on municipality. Standard errors in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Table IV

Main results. Instrumental Variables Estimates of the Effects of One Additional Year With Cable Television Coverage

	Men		Women
	Standardized Ability	High School graduate	High School graduate
(1) Aggregate fixed effects	-0.0068	-0.0036	-0.0005
+ municipality and parental covariates	(0.0029)	(0.0015)	(0.0017)
+ Pre-reform population density # cohort fixed effects	**	**	
(2) + Pre-reform municipality covariates	-0.0054	-0.0031	-0.0001
#cohort fixed effects	(0.0029)	(0.0015)	(0.0015)
	*	**	
(3) + Pre-reform ability	-0.0053	-0.0033	-0.0002
#cohort fixed effects	(0.0029)	(0.0015)	(0.0015)
	*	**	
ymean	0.08	0.67	0.75
N obs	279954	310427	293641
N muncipalities	430	430	430

Note: Each new model encompasses all of the preceding. "Aggregate fixed effects" includes municipality fixed effects and county-year fixed effects. "Municipality covariates" includes average years of schooling attained, male and female income levels, male and female employment rates, all measured in the year of birth. "Parental covariates" includes education level fixed effects and income for both parents, all measured in the year of birth. "Pre-reform population density" is the share of the municipality inhabitants living in a "densely populated" area in 1980. "Pre-reform municipality covariates" includes 1980 levels of the municipality covariates. "Pre-reform ability" denotes average ability score of men residing in the municipality in 1980. When adding municipality baseline characteristics-cohort interactions from row (1) to (2), the joint χ^2 values for the 65 added terms range from 128 to 170. Standard errors clustered on municipality. Standard errors in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

We build our discussion of the results on the estimates reported in row (3), which includes the most extensive controls for differential trends related to pre-reform local characteristics. That model is also the one we use as the basis for extensions in sections 5.1 and 6.1.

With the standardized cognitive ability score as the outcome, this specification gives an estimated coefficient on our television exposure measure of -0.0053, i.e. a negative effect of

exposure of 0.53 % of a standard deviation. Since the IQ scale has a standard deviation of 15, this estimated effect of one additional year of full television coverage would roughly correspond to a 0.08 points reduction in IQ. By comparison, Brinch and Galloway (2012) estimate the effect of one year of schooling to be around 3.7 IQ points using an education reform in Norway in the 1960s. Likewise, Carlsson, Dahl, Öckert, and Rooth (2015) use a quasi-experimental setting in Sweden to exploit variation in test taking date for young Swedish males preparing for military service. Their results imply that one year of schooling raises crystallized (synonyms and technical comprehension) test scores by around 20 % of a standard deviation, corresponding to around 3 IQ points, but has no effect on fluid (spatial and logic) intelligence tests. Taken at face value, our estimate thus indicates that 18 years of full cable TV coverage has a negative impact on cognitive ability (-1.5 IQ) comparable to around half a year's schooling. Further analysis show that the effects are concentrated at the middle and lower upper part of the ability distribution.

Moving on to high-school completion, our results indicate that one extra year of cable TV coverage reduces the probability of high-school completion for men by age 21 by around 0.3 percentage points. To again put the results in perspective, we note that the estimated effect on high-school completion of one year of cable TV exposure constitute 1/15 of the corresponding statistical association between one additional year of parental education and high school completion, as reported by Bratsberg, Raaum, and Røed (2012, Figure 5). For women, we find no effect at all on high-school completion, regardless of model specification. This shows that we are not simply picking up some general, local trends, and is consistent with the research showing greater importance of the home and school inputs for boys than for girls. Boys' higher impatience may also make them more susceptible to the temptation of easy entertainment at the expense of more cognitively challenging activities.

5 Alternative models and additional robustness checks

In this section, we first assess our findings robustness with respect to the source of identification. This is done by setting up a model with identification based on within-family variation in television exposure only (Section 5.1), and by exclusively using data from the largest municipalities (Section 5.2). Second, we take a closer look at the possibility of parental selection at baseline by using parental characteristics as outcomes in a "placebo" analysis (Section 5.3).

5.1 Family fixed effects

A particularly reliable source of identification of cable TV effects would be to compare brothers or sisters who have been subjected to different exposure intensities due to differences in age. Identification with family fixed effects will in practice only come from younger brothers or sisters having higher television exposure, thus we include fixed effects for sibling order in addition to family fixed effects to be sure not to pick up birth order effects. In addition, we include the full vector of controls from Equation (1), insofar as they are not absorbed by the family fixed effects. When running this demanding specification, the point estimates are no longer statistically significant; conf. Table V. It is reassuring, though, that the point estimates are almost identical to those from the baseline specification.

Table V

Instrumental Variables Estimates of the Effects of One Additional Year With Cable Television Coverage. With Family Fixed Effects.

	Men		Women
	Ability	High School graduate	High School graduate
TV	-0.0053	-0.0030	-0.0004
	(0.0140)	(0.0075)	(0.0104)
ymean	0.08	0.67	0.75
N obs	279954	310427	293641
N families with >1 sibling	54101	60755	54201

Note: All models are based on Equation (1), and include family fixed effects, (same-sex) sibling order fixed effects, municipality fixed effects, county-year fixed effects, municipality covariates (average years of schooling attained, male and female income levels, male and female employment rates), and interactions between cohort fixed effects and the 1980 levels of population density, the municipality covariates, and average ability score of men residing in the municipality. Standard errors clustered on municipality. Standard errors in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

5.2   Identification based on data from the largest municipalities only

As pointed out in Section 3, the use of county-year fixed effects in our main empirical analysis implies that we have not (so far) exploited data from Oslo, the capital. This is unfortunate, as Oslo has been in the forefront of the cable TV expansion development. As an alternative approach, we now focus exclusively on the most heavily populated areas in Norway, which were in the forefront of the cable television rollout; i.e. we construct two samples; one consisting of municipalities with a population in 1980 of above 20,000 (21 municipalities) and one with municipalities exceeding 30,000 inhabitants (10 municipalities). Using these samples addresses two concerns: One is that there may have been unobserved factors impacting cognitive skills and educational and labor market outcomes of young people in large cities and other urban areas in this period, and that this is picked up by our television measure, since the expansion largely took place in populous areas. Another concern is that the expansion to some

extent was demand-driven after all, and that the demand for cable TV could be correlated with the trends in our outcome measures. Though we cannot completely rule out that this is a possibility for very small municipalities, such a mechanism would be an unlikely factor to drive the results in a comparison between large municipalities.

Given that we only use a small number of municipalities with similar population density and demographic composition in these exercises, we substitute common year fixed effects for both the county-by-year fixed effects and for the pre-reform municipality characteristics interacted with cohort dummies. This implies the foundation for identification becomes very different from the one used in the baseline model. The results are shown in Table VI. Standard errors blow up with the reduced sample size, but the estimated effects remain similar – though far from identical – to those from the baseline model.

Table VI

Instrumental Variables Estimates of the Effects of One Additional Year With Cable Television Coverage. Data From the Largest Municipalities Only

	Men		Women
	Ability	High School graduate	High School graduate
10 largest municipalities (population in 1980>30,000)	-0.0091 (0.0068)	-0.0075 (0.0035) **	0.0037 (0.0033)
ymean	5.41	0.69	0.76
N obs	78957	87072	81800
N muncipalities	10	10	10
21 largest municipalities (population in 1980>20,000)	-0.0039 (0.0038)	-0.0063 (0.0020) **	0.0024 (0.0019)
ymean	5.35	0.68	0.75
N obs	104984	116028	109430
N muncipalities	21	21	21

Note: All models include municipality fixed effects, year fixed effects, municipality covariates (average years of schooling attained, male and female income levels, male and female employment rates) and individual-level covariates (education level fixed effects and income for both parents). Robust standard errors. Standard errors in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

5.3 Parental selection into treatment

Even though we measure television exposure at the baseline (municipality of birth), we may be concerned that would-be parents have already selected into certain municipalities before having children. If this generated an increasingly negatively selected population in TV-intensive municipalities, this could distort our estimates. To investigate this, we perform placebo regressions using as dependent variables the (pre-determined) parental covariates we use as control in our baseline specification. Apart from the absence of the parental covariates, the models estimated here correspond to those in the table of our main results, Table IV. The results are shown in Table VII. The estimated coefficients are small and do not show any clear pattern.

Table VII

Placebo regressions – OLS Estimates of the Effects On Parental Characteristics of One Additional Year With (Future) Cable Television Coverage In the Child's Birth Municipality

	Father			Mother		
	High School degree	University degree	Income	High School degree	University degree	Income
(1)	-0.001	0.001	-0.123	-0.001	0.000	-0.043
	(0.001)	(0.001)	(0.108)	(0.001)	(0.001)	(0.073)
(2)	-0.001	0.002	0.032	-0.001	0.001	-0.089
	(0.001)	(0.001) *	(0.087)	(0.001)	(0.001)	(0.074)
(3)	-0.001	0.002	-0.032	-0.001	0.001	-0.089
	(0.001)	(0.001) *	(0.087)	(0.001)	(0.001)	(0.074)
ymean	0.70	0.19	66.02	0.64	0.16	23.70
N obs	378414	378414	378414	378265	378265	378265
N muncipalities	430	430	430	430	430	430

Note: Parents of both boys and girls. Parents are included the first time they appear as a parent in the sample. (1) includes municipality fixed effects, county-year fixed effects, "Municipality covariates" (average years of schooling attained, male and female income levels, male and female employment rates, all measured in the year of birth), and the share of the municipality inhabitants living in a "densely populated" area in 1980 interacted with cohort fixed effects. (2) includes also 1980 levels of the municipality covariates interacted with cohort fixed effects. (3) includes also average ability score of men residing in the municipality in 1980 interacted with cohort fixed effects. Standard errors clustered on municipality. Standard errors in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

6   Mechanism

Since we do not have geographically disaggregated data on television watching, we can only estimate the intention-to-treat effect of television coverage; however we can shed some light on the likely mechanism by analyzing heterogeneous effects across different ages of exposure and also by looking at auxiliary data sources regarding youths' actual time use.

6.1   Exposure at different ages

In our baseline model, we have assumed that commercial television exposure has the same impacts on cognitive ability and schooling outcomes, regardless of its timing within the 0-18 year age span. This is a questionable assumption. The literature on the importance of relatively early environments (Heckman, 2006; Chetty, Hendren, and Katz, 2015; Conti, Heckman, and Pinto, 2015) and "critical periods" for cognitive development (Bleakley and Chin, 2004; van den Berg, Lundborg, Nystedt, and Rooth, 2014) suggests strongest effects in the pre-school and elementary school periods. On the other hand, the fact that actual television watching in general increases with age may pull in the other direction (see Figure 5 in the next subsection).

To shed some light on this issue, we have split the television exposure variable into three separate periods of six years each, corresponding to the pre-school, elementary school, and middle and high school periods, and studied the impacts of television exposure of these three periods in separate models. As we can see from Table VIII, the prediction that the relatively early periods are particularly important is confirmed in this analysis. The impacts on cognitive ability are largest for exposure during pre-school and elementary school age, whereas the impacts on high school completion are largest for exposure during elementary school age. While the results in Table VIII stems from separate regression models, we have also estimated instrumental variables models where we enter all the age-specific exposure variables simultaneously. It turns out to be difficult to identify such a model in practice, however, since

the three endogenous variables and their respective instruments are so highly correlated, and since there is an unfortunate deterministic relationship between the three instruments (for the municipalities of birth, it is not possible to increase exposure in an early period without at the same time increase it in later periods). That being said, the point estimates coming out of such an analysis are not very different from those shown in Table VIII, and the conclusion that the two earliest periods are most important remains the same.

Table VIII

Instrumental Variables Estimates of the Effects of One Additional Year With Cable Television Coverage. Separate Regression Models By Age of TV Exposure

	Men		Women
	Ability	High School graduate	High School graduate
TV 0-5	-0.0073	-0.0039	0.0010
	(0.0042)	(0.0019)	(0.0020)
	*	**	
TV 6-12	-0.0078	-0.0063	-0.0025
	(0.0063)	(0.0035)	(0.0032)
		*	
TV 13-18	-0.0031	-0.0003	-0.0001
	(0.0078)	(0.0043)	(0.0048)
ymean	0.08	0.67	0.75
N obs	279954	310427	293641
N muncipalities	430	430	430

Note: All models are based on Equation (1), and include municipality fixed effects, county-year fixed effects, municipality covariates (average years of schooling, male and female income levels, male and female employment rates), individual-level covariates (education level fixed effects and income for both parents), and interactions between cohort fixed effects and the 1980 levels of population density, the municipality covariates, and average ability score of men residing in the municipality. Standard errors clustered on municipality. Standard errors in parentheses.* $p<0.10$, ** $p<0.05$, *** $p<0.01$.

6.2 Television consumption

Access to commercial television channels can affect the nature of television consumption in two ways: By affecting the total time spent watching TV and by affecting the type of programs

being watched. In this subsection, we use auxiliary data from media surveys to shed light on these possible mechanisms. Statistics Norway has since 1991 undertaken surveys of the population's media habits. When it comes to television, respondents are asked both about what type of connection they have, and about how much they watched yesterday. An effort is made to obtain responses from kids as young as 9 years old, thus for the age group 9-18 we can get a quite good picture of how having a cable connection correlates with actual television watching in the period from 1991 onwards. **Error! Reference source not found.**VI shows age profiles for actual television watching "yesterday" for those with and without a cable television connection. Up to age 14, there is a steady increase in the number of minutes spent on television watching for both groups. And those with cable connection watch considerably more television than those without. The two age profiles have a very similar shape, however, suggesting that the heterogeneous effects by age estimated above are not simply due to differences in the amounts of television consumption.
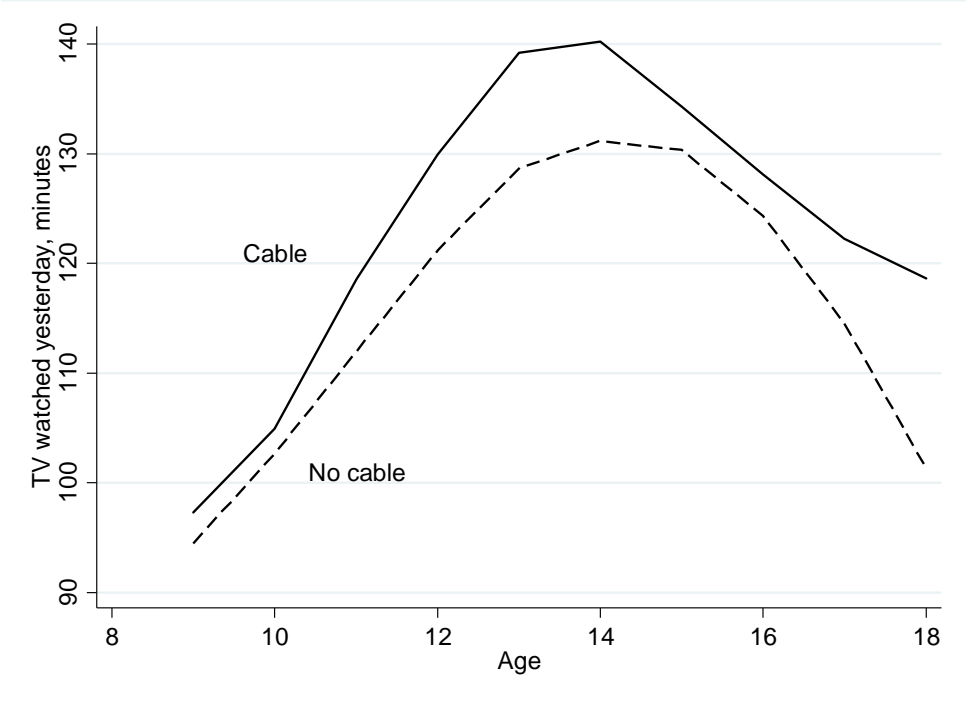

Figure VI

Television Watching by Age (Smoothed), From the Media Use Survey 1991-2004

The Norwegian Broadcasting Corporation (NRK), which held a legal monopoly until 1981, has had and continues to have a broad public service mandate. In their articles of association, it is stated that "The purpose of the NRK's overall public media services is to meet democratic, social and cultural needs in society (NRK, 1997)." Further, "[t]he NRK should promote public debate," "offer services which can be a source of inspiration, reflection, experience and knowledge through programs of high quality," and "contribute to public education and learning." The new channels that arrived with cable television had no public service mandate, and no regulation of content other than pornography and violence (Regulations relating to broadcasting, 1997). And their program profiles were indeed markedly different: According to a comparative analysis undertaken in 1993, the content of the main Scandinavian cable channels in Norway (TVNorge and TV3) were 75 % entertainment and 10 % advertisements, while that of the NRK was almost 40 % news, documentaries, science, nature, or similar (NRK, 1993) and no advertisements. It is also clear that the new channels were watched – in 1992, the NRK's share of total viewing time was down to 64 % (MMI, 1992).

In the media survey, respondents are also asked what type of programs they watched yesterday, and each program is coded as belonging to one of several categories. To examine the relationship between cable television access and the type of programs being watched, we aggregate these categories into two groups: "Educational" (news, debates, information and documentaries, science, nature, quiz) and "Other" (sports, kids/youth, religious, theatre and ballet, classical music, films, TV series, pop music, other entertainment, other). Thus we have measures of how many shows of these types each individual watched yesterday. We also investigate total time spent watching television and spent reading yesterday. To come as close as possible to the approach in our main analysis, we include fixed effects for area type (population>100 000, 20 000-100 000, <20 000, "rural") and year.

The results are presented in Table IX. They indicate that for both boys and girls, access to cable television implies much more television watching, as well as a marked shift toward non-educational shows. There is one interesting difference in the male and female responses; however, namely that television watching appears to substitute for reading activities for boys, but not for girls. The fact that the impact of cable television access on the overall television consumption pattern is quite similar for boys and girls suggests that the heterogeneous impact on high school graduation that we estimated earlier is either due to television watching crowding out reading to a greater extent for boys than for girls, or that boys are more sensitive to changes in television exposure.

Table IX

Cable Connection and Television Consumption of Adolescents Aged 9-18

| | Time use | | Television content | |
| | Minutes | | Number of shows wathced | |
	TV	Reading	Educational	Other
Boys				
Cable	11.5	-5.4	-0.006	0.390
	(5.4)	(2.2)	(0.048)	(0.084)
	**	**		***
ymean	128	35	0.53	1.82
R-sqr	0.048	0.045	0.015	0.038
N	2112	2113	1675	1675
Girls				
Cable	18.8	0.4	-0.063	0.402
	(5.0)	(2.4)	(0.041)	(0.082)
	***		*	***
ymean	115	36	0.36	1.71
R-sqr	0.058	0.063	0.032	0.044
N	2005	2004	1565	1565

Note: Time use and television consumption yesterday, individuals aged 9-18. All models include fixed effects for area type, year, and age, and a dummy variable for a connection parabolic antenna. Content categorization: "Educational" (news, debates, information and documentaries, science, nature, quiz), "Other" (sports, kids/youth, religious, theatre and ballet, classical music, films, TV series, pop music, entertainment, other). Four area types: population>100 000, 20 000-100 000, <20 000, "rural". Robust standard errors. Standard errors in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Source: Media Use Survey 1991-2004.

7   Conclusion

In this paper, we have used the geographically staggered expansion of cable TV in Norway during the 1980s and 1990s to examine the impacts of access to commercial TV channels on children and youths. Our outcome measures include ability test scores (measured at age 18) for men and high school completion at age 21 for both men and women. Our findings indicate that commercial TV affects ability test scores and high school completion rates *negatively* for men, but has *no effect* on high school completion for women. The estimated effects on male outcomes are moderately sized, but far from negligible. For example, one year of full cable

television coverage lowers intelligence test scores by more than 0.5 % of a standard deviation, corresponding to 0.08 IQ points. This is roughly 2 % of the previously estimated impact of one year extra schooling (Brinch and Galloway, 2012). The same increase in cable TV reduces the high-school completion rate of men at age 21 by around 0.3 of a percentage point. Even though these point estimates appear small, it should be kept in mind that they accumulate each exposed year.

We started out this paper by pointing out that many countries have seen a recent decline in intelligence test scores and questioned whether this could be explained by the increased access to commercial television channels. During the data period covered by our analysis, the average IQ score among Norwegian male conscripts declined by around 1.9 points (conf. Figure IV), and average cable television exposure increased by three years. Based on our baseline model and data for aggregate cable televsion coverage, we estimate that the expansion of cable TV can account for a 0.24 point decline; i.e. around 12 % of the overall decline. Hence, although we do find negative effects of commercial televion access on cognitive ability, the rollout of cable television can only explain a modest fraction of the apparent overall decline in IQ scores.

Another motivation was the educational gender gap. In the same manner as with intelligence test scores, we can calculate cable television's contribution to the increasing gender gap in high school graduation. Taking the estimates of a zero effect for women and a negative effect of 0.33 percentage points per year of exposure for men, we get that cable television explains 1 percentage point decline in high school gradution for men in this period, or about 1/6 of the increase in the gender gap. One may speculate whether the asymmetric effect across gender, which has a priori support in previous research, applies also to other types of media that provide light entertainment.

The negative impacts are largest for TV exposure before the age of 12 years. It is probable that the developmental impacts of increased supply of TV entertainment during childhood depend both on the extent to which the actual consumption of entertainment is regulated by parents and on the kind of activities TV consumption substitutes for. Data from time-use and media surveys indicate that the increase in TV consumption to a large extent substituted for reading, particularly for boys; hence, one may hypothesize that the negative effects identified in our paper do not stem from increases in TV consumption *per se*, but rather by the resultant reduction in reading activities.

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