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The Legacy of Conflict: Regional Deprivation and School Performance in Northern Ireland[1]

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Abstract: The relationship between deprivation and educational outcomes has been the subject of a long-running and deep debate in the economic literature. Recent discussions have focused on causality, with experimental and quasi-experimental approaches taken, yet, predominantly, the literature continues to proxy deprivation with measures of wealth. This paper explores a much wider measure and identifies a causal relationship between regional deprivation and school performance in Northern Ireland. Combining panel data on Key Stage II results from each of Northern Ireland's primary schools with the 2005 Northern Ireland Multiple Deprivation Measure, we show the net negative impact of this wider measure, whilst an extension explores the impacts of each single domain. Using an error-component two-stage least squares model, we account for school and neighbourhood selection and the potential endogeneity of our deprivation measure, showing spatial variation in historical violence, which occurred during "The Troubles", to be a valid instrument for deprivation. Our results confirm the negative impact of deprivation frequently found in the literature but also that, when the impacts of other deprivation domains are accounted for, education and crime deprivation, and not financial deprivation, play a significant role in determining outcomes. This confirms the limitations of using wealth as a proxy for neighbourhood deprivation, whilst suggesting that policies focusing only on income redistribution will be unsuccessful in improving education outcomes of those exposed to deprivation.

Keywords: Violent Conflict, Regional Deprivation, Human Capital Accumulation, Northern Ireland

JEL classifications: I24, R23

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1 Introduction

In Northern Ireland, a low-intensity conflict, colloquially known as "The Troubles" occurred between the death of Francis McCloskey in 1969 (Sutton, 1994) and the joint paramilitary ceasefires of 1994. We aim to exploit the uneven spatial distribution of this historical violence (Figure 1) and its relationship with adverse neighbourhood observables, in order to explore the relationship between deprivation and primary school performance. It is known that primary-level educational achievement plays an important role in child / adolescent development and future labour market outcomes, yet the topic has received little attention to date (Gibbons, 2002).

We employ the Northern Ireland Multiple Deprivation Measurement (NIMDM), which captures differences in neighbourhood quality via seven different domains; income, employment, education, health, living environment, proximity to services and crime. We match this regional deprivation measure to performance data for each primary school in Northern Ireland between the 2000/01 and 2010/11 academic years. Performance is measured by the proportion of children at each primary school achieving the minimum pass (Level 4) in the standardised national Key Stage II exams. Primary schools in the UK serve local communities and are typically distributed over small geographic areas. We propose this means that primary schools are closely linked to the location-level unobservables that form the background of the neighbourhood effects literature (Weinhardt, 2010, for example).

Noting the potential endogeneity of the NIMDM measure, we exploit a dataset of deaths directly linked to "The Troubles" (Sutton, 1994), which has been geographically mapped to Northern Ireland's 582 electoral wards by Ferguson (2012). Using the total number of deaths by ward and calculating the inverse distance weighting matrix to capture violence intensity in bordering wards, we have two instruments for the NIMDM. This instrumentation allows us to account for both the endogeneity of our deprivation measure and any unobserved school-level heterogeneity. Given the potential for selection into, or out of, neighbourhoods (wards) and school districts, we implement an error component two-stage least squares regression (Baltagi, 1981).

Results in the first stage show a strong relationship between historical violence and contemporary deprivation. Beginning the analysis in the 2000/01 school year ensures that all children in our sample began their education after the conflict had ended in 1994, precluding any direct effects of continued violence. Consequently, in the second stage we show the impact of deprivation on primary school performance. We extend our analysis by disaggregating the NIMDM measure into its constituent domains, showing that the effects of exposure to education deprivation and crime deprivation are the most important determinants of poorer primary education outcomes. In contrast to the frequent use of individual, household or regional wealth as a proxy for deprivation, however, we find no

unique effect from either the financial deprivation or employment deprivation domains, suggesting any policies focused only on income redistribution will fail to mitigate the negative impacts of prolonged deprivation or improve social mobility. Instead, a wider approach to combating uneven school performance is required. Given the relationship between deprivation and violence in Northern Ireland (Honaker, 2010), these results also imply that these persisting regional inequalities may prove to be an obstacle for the continued peace process.

The remainder of this paper is set out as follows: in the next section (2), we discuss and review the literature relevant to this study. In Section 3, we describe the data we use; in Sections 4 and 5, we introduce our methodology and results, respectively and, finally, we conclude in Section 6.

2 Literature Review

The positive role played by good primary education on the formation of human capital and of individuals' future labour market outcomes is uncontroversial (Sparkes, 1999). This notion, however, raises two important questions. Firstly, if there is a link between deprivation and primary school outcomes, then issues relating to a cycle of poverty must arise, suggesting that those children born to the most deprived parents would be those most likely to spend their adult lives in poverty. Secondly, a potential issue of endogeneity is raised, which appears in the literature as early as Tolley and Olsen (1971). Their logic argues that the richest regions have the greatest ability to invest in education infrastructure, suggesting richer parents gain access to better schools. Financial deprivation, therefore, plays only an indirect role in determining education outcomes, with the mechanism of this effect being school quality, rather than income. Whilst this paper does not, necessarily, subscribe to this notion, we question the over-reliance on wealth to proxy deprivation throughout the literature.

Although these relationships are evident, the link between deprivation and primary school outcomes is understudied, as Gibbons (2002) notes. Until recently, this could be explained by the lack of detailed breakdown of primary school performance data. Whilst census data and detailed household panel surveys have provided information on post-primary achievement, such differentiations have not been available at primary school level. Unsurprisingly, therefore, much of the literature to date has looked at post-primary performance.

This literature has also, most frequently, looked at financial deprivation. The measurement of financial deprivation is difficult however, due to both controversial definitions and lack of data availability. A series of proxies, therefore, have been used; such as parental education (Cremer et al., 2003), income (Blau, 1999) and occupation (Oreopoulos and Stevens, 2008). Each of these proxies may still suffer identification issues, however. Ed-

ucation, income and occupation could equally be related to unobservable characteristics, such as latent ability, for example. Furthermore, the transfer mechanisms of financial deprivation to education outcomes are not immediately clear.

Fuller reviews of the financial deprivation literature can be found in the surveys of Haveman and Wolfe (1995) and Mayer (1997). Noting the potential for unobservable neighbourhood characteristics, however, more recent literature has turned to a quasi-experimental approach. Milligan and Stabile (2008) and Duncan (2011) use government income transfers. Both find positive relationships between income and educational attainment. Løken (2010) and Løken et al. (2012) use the uneven geographic dispersion of the Norwegian oil boom as exogenous variation and show pronounced positive impacts of increased income on school attainment amongst low income families. Weinhardt (2010) shows the negative impact of moving into a "low-quality" neighbourhood, where "quality" is measured by the proportion of social housing.

Bayer et al. (2008), Davis-Kean (2005) and Cutler and Glaeser (1997) support the neighbourhood findings of Weinhardt (2010), whilst Oreopoulos and Stevens (2008) and Jacob (2004) show no significantly worse outcomes, based on proxies of quality. Goux and Maurin (2007) and Gibbons and Silva (2008) note the potential impact of selection into neighbourhoods, however. Poorer families have less choice over where to live and, therefore, have less access to the best schools. This effect is also noted in Bayer and Ross (2006). Solon et al. (2000) find only little correlation between neighbouring children's educational attainment, suggesting that adult socio-economic status is more strongly determined by family characteristics than by neighbourhood characteristics. We suggest that early life outcomes, such as primary school performance, are likely to be more strongly associated with neighbourhood characteristics than educational outcomes later in life, i.e. when the personal development and aspirations become more individually distinguished and therefore greater divergence in educational achievement is to be expected.

Despite the focus of this literature we argue, along the lines of Dahl and Lochner (2008), that income deprivation may be endogenous to the process. The increased attainment due to an increase in income noted in these papers may transmit itself through other unobservables that have also improved as a result of neighbourhoods becoming wealthier. Following Tolley and Olsen (1971), more resources may be available for local schools, improving their quality. In the cases of Løken (2010) and Løken et al. (2012), for example, this notion seems particularly pertinent – it seems unlikely that only families, and not an array of local infrastructure, benefitted from the oil boom. Thus, both children's opportunities and family income remain influenced by the same underlying factors.

Financial deprivation, therefore, at best seems to be only one of a number of poten-

tial sources of deprivation that could impact on children's outcomes. McLoyd (1990), for example notes the impact of health on individual outcomes, with the causal mechanisms also well established. Exposure to health deprivation, therefore, may not be intrinsically linked to financial deprivation but, intuitively, seems likely to impact on the outcomes of those exposed. Perhaps surprisingly, however, little work has looked at the intergenerational transfer of this relationship. Sun and Yao (2010) show a negative impact on the probability of entering and finishing middle school as a result of parental health shocks, while Choi (2011) shows that poor parental health is a significant indicator of their children's educational achievements. The thinness of this literature is discussed in Bratti and Mendola (2011), who find a negative impact on education enrolment in Bosnia as a result of self-reported poor maternal health, especially poor mental health.

Similar to the civil war in Bosnia in the early 1990s, the conflict in Northern Ireland has resulted in a considerably larger prevalence of mental health issues within its population compared to other countries. Post-traumatic stress disorder, depression and similar symptoms can be found until today among individuals who were exposed to the conflict (Curran, 1988; Loughrey and Curran, 1988; Muldoon and Downes, 2007). These outcomes are likely to be reflected in the deprivation measure on health, and may, as in the study by Bratti and Mendola, impact on children's school performance via, e.g., impaired interaction between depressed parents and their children, yet may not be, explicitly, accounted for in a financial deprivation measure.

The continuing debate in the literature over both outcomes and methodologies suggests that the role of deprivation as a driver of educational outcomes is considerably more complex than simply an absence of financial resources at an individual or household level. Few previous studies tried to overcome the issues of unobservable neighbourhood effects and the complex series of interactions that define deprivation wider than simply as financial inequality. Examples are Lupton (2001), who uses a multiple deprivation index to study post-primary outcomes in the UK, and Gibbons (2002), who uses primary school level data and several measures of neighbourhood wealth in England.

Similar to Gibbons (2002), we use primary school level data. We believe that, given the absence of individual-level explanatory variables, such as time spent doing homework, or number of missed school days per year, little is lost by looking at average school level achievement. In the context of Key Stage II examinations, which each individual only sits once, a panel facilitating the measurement of individual effects could not be developed. This contrasts to our school level data, which allows modelling of school level unobservables and potential neighbourhood effects. Using variation in the proportion of individuals achieving the minimum pass rate (Level 4) at Key Stage II, we employ a nationally comparable measure of achievement at this level. Following Lupton (2001), we suggest that deprivation extends significantly further than comparison of incomes.

Accordingly, we use the NIMDM, which builds an index of deprivation from seven different domains.

In the specific case of Northern Ireland, the authors are aware only of the studies of Shuttleworth (1995); Shuttleworth and Daly (1997) and Cummings et al. (2011). Cummings et al. (2011) look at the relationship between violence and children's "adjustment problems", which can easily be extrapolated to our question, whilst the others look at the direct impact of violence on those who were exposed to it. To our best knowledge, this is the first paper to explore the role of multiple deprivation on primary school level outcomes, and certainly the first to do so in post-conflict Northern Ireland. Furthermore, given our instrumentation of the multiple deprivation measures and our error-component modelling strategy, we believe that this work overcomes many of the identification issues that have been prevalent in the literature to date.

3 Data

We combine three major data sources for our empirical analysis. School performance data is taken from the Department of Education of Northern Ireland (DENI). Deprivation data is sourced from the Northern Ireland Multiple Deprivation Measure (NIMDM) from 2005, which was provided by the Northern Ireland Statistical Research Agency (NISRA) and obtained by the Social Disadvantage Research Centre at the University of Oxford. Finally, violence data is based on the authors' own construction of Sutton (1994).

We employ a panel of primary school data that runs from 2000/01 until 2010/11, with the exception of the 2003/04 academic year, which is unavailable due to a teachers' strike. We begin our analysis in 2000/01 as this is the first year in which all children in the cohort began their education after the 1994 ceasefires[1], precluding any direct effects of violence on their outcomes. We exclude private preparatory schools[2] and schools that did not provide data for Key Stage II achievements or Free School Meal Entitlement (FSME). This results in an unbalanced panel of $n \times T = 5,937$ school-years. We include information on the language used in each school (English or Gaelic), the number of pupils per school, the size of the examined cohort and the teacher-pupil ratio in each school. The average proportion of children achieving at least Level 4 in English and Mathematics in the Key Stage II exams is used to proxy school performance and serves as the outcome variable for our analysis. Key Stage II is an annual, formal and standardised national exam taken by children towards the end of primary school, at approximately age 10.

[1] We accept that some violence, fatal and otherwise, has been ever-present in Northern Ireland since 1994. This violence, however, is not on the same scale of the pre-1994 violence and is controlled for in our analysis.

[2] Whilst most primary schools in Northern Ireland service local communities, it is unlikely that most pupils attending preparatory schools live in the region(s) surrounding the school. On this basis, we exclude these institutions.

Our regional deprivation measure is the NIMDM from 2005. The NIMDM is a five-yearly measure that aims to identify small-area concentrations of deprivation in Northern Ireland and provides information on seven domains, each of which is designed to measure a distinct type of deprivation. We use the 2005 wave as it is temporally closer to more of our data than the 2010 wave. A previous version of the NIMDM from 2001 is not geographically comparable to 2005, whilst changes in the sub-indicators between 2005 and 2010 preclude like-for-like comparison of these years. The domains and their weights, suggested by NISRA, in the multiple measure are as follows: Income Deprivation (25%), Employment Deprivation (25%), Health Deprivation and Disability (15%), Education, Skills and Training Deprivation (15%), Proximity to Services (10%), Living Environment (5%) and Crime and Disorder (5%).

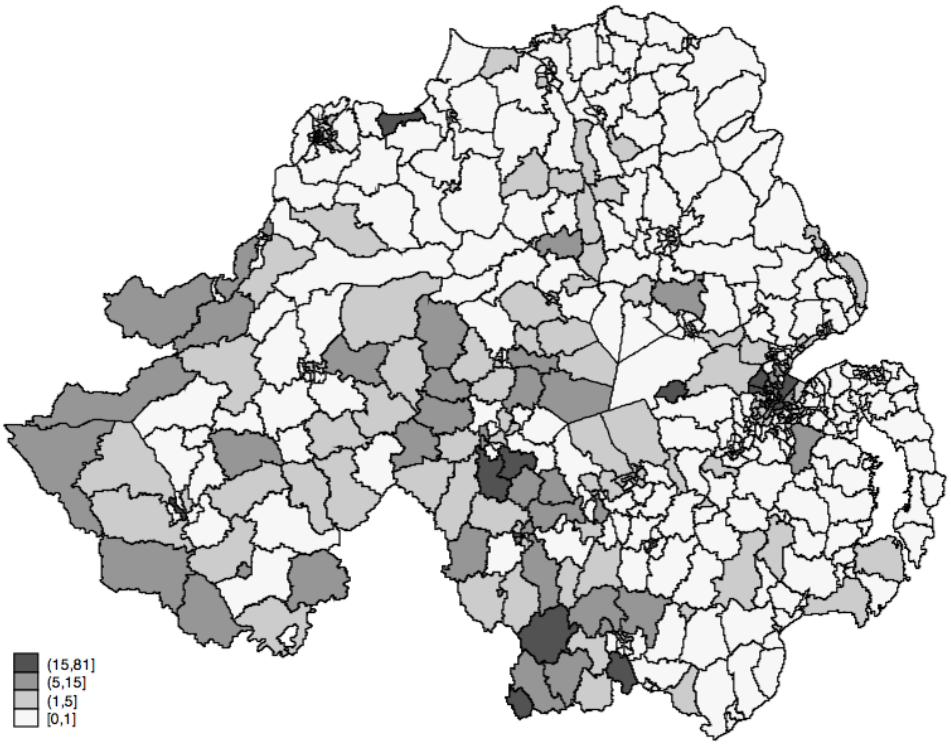
Each domain is built from a series of sub-indicators. Income deprivation, for example, is based on indicators such as the proportion of households on Income Support, the proportion of households with State Pensions only and other indicators such as proportion of the population receiving Jobseekers Allowance, Housing Benefit, Working Tax Credits, Child Tax Credits, etc. A full list of each domain's indicators can be found in Table A4 in the Appendix. We construct an overall multiple deprivation measure which consists of the weighted average of all domains. Following (Haisken-DeNew and Sinning, 2010, e.g.,), who show how weighting of social deprivation can effect the estimated impact on outcomes variables, we apply the weights suggested by NISRA and use equal weights as a robustness check. We extend the analysis to test the impact of each single domain, whilst controlling for the impact of the remaining domains, which offers deeper insight into the transfer mechanisms and further overcomes the weighting issue discussed above.

We choose Northern Ireland's 582 electoral wards as our level of geographic disaggregation, due to the presentation of both deprivation and violence data at this level[3]. We extract data from Sutton's (1994) database, which provides detailed information on fatal incidents that are directly related to the conflict. We construct a variable, *deaths*, which is the total number of fatalities which occurred in a ward between the death of Francis McCloskey in June 1969 and the PIRA ceasefire of August 1994. Figure 1 displays the spatial variation of deaths by electoral wards. In total, the conflict counts almost 3,600 deaths. Over 200 wards experienced no fatal violence during the conflict. Others experienced in excess of 75 fatalities. Whilst some notable incidents have occurred since 1994, fatal violence has been extremely rare since the paramilitary ceasefires.

Table 1 provides summary statistics on conflict intensity. It can be seen that the number of deaths per ward ranges from 0 to 81 and has a mean of 4.77. In 61% of all wards, at least one death occurred, with more than five occurring in 25% of wards and

[3]A larger disaggregation, Super Output Areas (890), also exists but is not feasible due to a lack of other control data at this level. We do not believe the lower disaggregation of electoral wards is problematic to our analysis, however, as on average each ward contains only 1.9 primary schools.

Figure 1: Number of Conflict-related Deaths by Wards between 1969 and 1994 in Northern Ireland



Source: Authors' construction using data by Sutton (1994).

more than ten deaths in 15% of wards. We divide the total number of deaths by the resident population in 2001.[4]

We construct a spatial lag of violence[5], in order to increase our instrumentation options. This variable measures the impact on deprivation of living close to a high-violence area. To this historical violence data, we add data on the annual number of contemporaneous bombing and shooting incidents to control for any continuing violence[6].

Table 2 provides summary statistics on the overall NIMDM score and the single domains, school level variables and population size by ward and age. We provide these descriptive statistics for two samples: schools located in areas of high violence ($\geq$ 5 deaths) and schools located in areas of low violence ($<$ 5 deaths).

In low-violence areas, the proportion of children meeting or exceeding the minimum

[4]The geographic boundaries of the wards used in this paper did not come into common use until the census in 2001. Accordingly, we use population data from this year as a proxy of deaths per capita. Although contemporaneous population data would be more desirable, earlier data do not exist at this unit of analysis.

[5]We construct a row-normalised, inverse-distance spatial weighting matrix. Due to Northern Ireland's small geographic size, we do not truncate the impacts of "distant" violence.

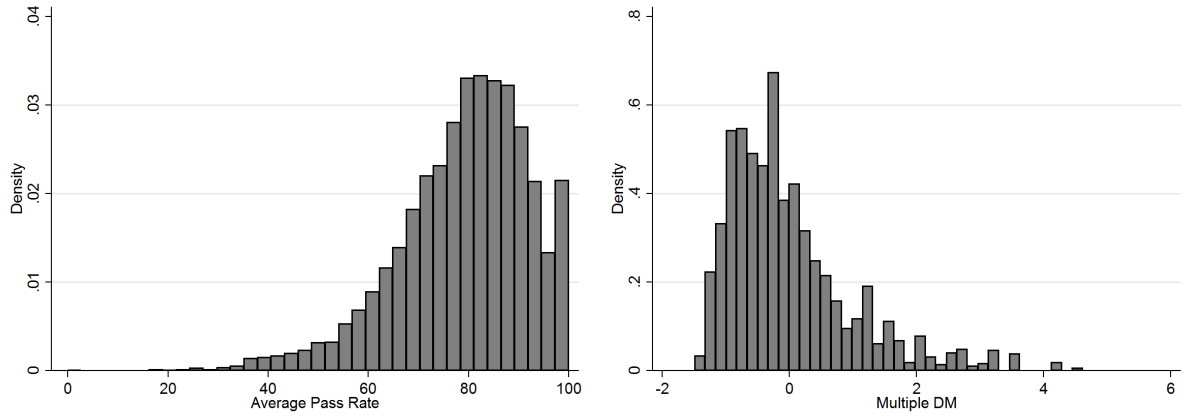
[6]These data were provided on request from the Police Service of Northern Ireland (PSNI) and are disaggregated to District Crime Units (DCU), which are significantly larger than electoral wards, explaining the high number of incidents recorded.

Table 1: Descriptive Statistics Violence Data

	Mean	Std.Dev.	Min	Max
No. of Deaths by Ward	3.67	7.88	0	81
Deaths per 1,000 inhabitants	1.21	2.40	0	25
No. of Deaths ≥ 1	0.61	0.49	0	1
No. of Deaths ≥ 5	0.21	0.41	0	1
No. of Deaths ≥ 10	0.10	0.29	0	1
N		5937		

Note: Authors' calculations based on Sutton (1994).

Figure 2: Average Pass Rates and MDM Score Density



Source: Authors' construction.

standard pass rate stands at 79.62%, whereas in high-violence areas, 77.67% of students reach this standard, with the difference being statistically significant. High violence areas are typically larger in terms of population and are significantly more deprived than low-violence regions, with an average NIMDM score of 6.8 in high-violence areas and 5.1 in low-violence areas. Figure 2 shows the distribution of the proportion of children meeting or exceeding the minimum standard pass rate and the NIMDM score.

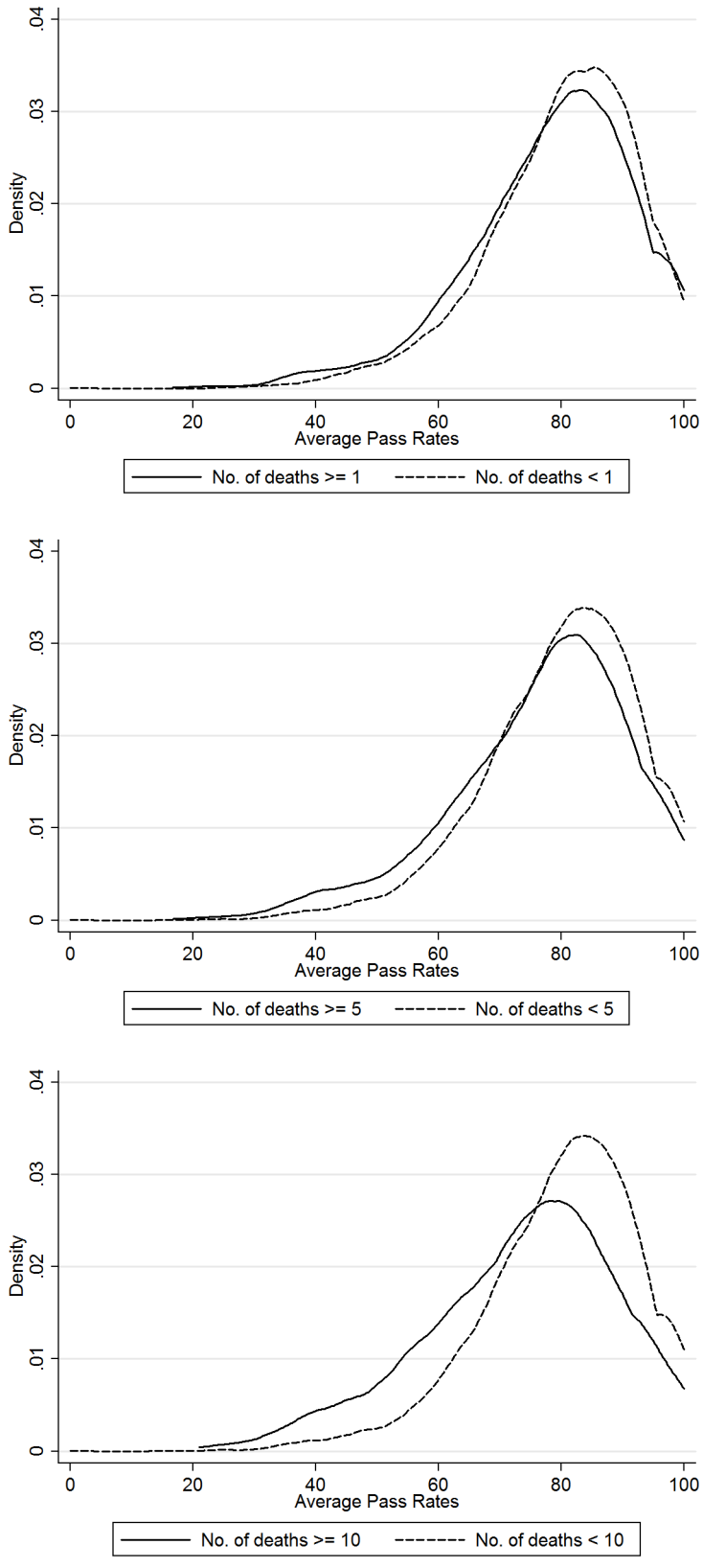
For the regression analysis, the NIMDM scores are standardised with mean zero and a standard deviation of one. In Figure 3, we provide Kernel density plots of average pass rates for high ($\geq$ 10 deaths), medium ($\geq$ 5 deaths) and low ($\geq$ 1 death) conflict regions. It can be seen that, as violence increases, the density plots diverge; with a higher density of high pass rates in low-violence regions.

Table 2: Descriptive Statistics School Data

	Low Violence Area		High Violence Area		Difference	
	Mean	Std.Dev.	Mean	Std.Dev.	Diff	SE
Average Pass Rate	79.76	(12.64)	76.71	(14.73)	3.05***	(0.42)
Number of Pupils	31.42	(24.13)	28.24	(19.25)	3.18***	(0.74)
Total enrolment	220.8	(158.25)	200.4	(132.29)	20.4***	(4.9)
Pupil-teacher ratio	20.16	(2.95)	19.35	(2.89)	0.81***	(0.09)
Gaelic exams	0.01	(0.12)	0.02	(0.15)	-0.01*	(0.00)
Catholic School	0.44	(0.50)	0.59	(0.49)	-0.15***	(0.02)
Free School Meal 10-20%	0.35	(0.48)	0.26	(0.44)	0.09***	(0.01)
Free School Meal 20-40%	0.26	(0.44)	0.30	(0.46)	-0.05***	(0.01)
Free School Meal $>$ 40%	0.08	(0.28)	0.26	(0.44)	-0.18***	(0.01)
Catholic inhabitants (%)	42.46	(29.93)	57.75	(27.70)	-15.29***	(0.94)
All Persons 0-15	690	(337.33)	743	(270.98)	-54***	(10)
All Persons 16-39	1022	(473.02)	1156	(727.50)	-134***	(17)
All Persons 40-59/64	827	(309.10)	855	(302.87)	-28***	(10)
All Persons 60/65+	467	(174.45)	534	(234.86)	-67***	(6)
Bombing incidents	2.84	(5.31)	6.63	(20.20)	-3.79***	(0.33)
Shooting incidents	4.55	(7.12)	9.57	(19.92)	-5.02***	(0.35)
Multiple DM	5.01	(2.79)	7.51	(4.55)	-2.50***	(0.10)
Income DM	0.20	(0.10)	0.31	(0.14)	-0.11***	(0.00)
Employment DM	0.15	(0.05)	0.20	(0.07)	-0.05***	(0.00)
Education DM	20.30	(13.23)	30.45	(20.42)	-10.15***	(0.48)
Health DM	-0.17	(0.60)	0.28	(0.87)	-0.45***	(0.02)
Services DM	-0.33	(0.76)	-0.23	(1.05)	-0.10***	(0.03)
Living Env. DM	21.49	(10.88)	30.61	(13.56)	-9.12***	(0.37)
Crime DM	17.17	(16.24)	25.21	(24.02)	-8.04***	(0.58)
N	4695		1242		5937	

Note: Authors' calculations based on primary school data from DENI, NIMDM scores from NISRA (2005), conflict data from Sutton (1994) and contemporary violence data from PSNI. In a high violence area, at least 5 deaths occurred.

Figure 3: Average Pass Rates Density by Violence Intensity



Source: Authors' construction.

4 Estimation Methods

As shown in the descriptive statistics, the unconditional relationship between regional multiple deprivation and school performance is negative. This relationship is unsurprising but questions remain about the causal relationship. Is there a direct (causal) impact of deprivation on children's outcomes, or do only parents with lower ability live in deprived areas, suggesting only a correlation transmitted via, e.g., ability? Indeed, should we implicitly assume a causal relationship, these notions remain important for interpretation of our outcomes, particularly in terms of the scale of the coefficients.

As is known from the literature on the intergenerational transmission of human capital, children's educational achievement depends strongly on the education and health states of their parents (e.g., Black et al., 2005; Choi, 2011; Haveman and Wolfe, 1995; Holmlund et al., 2011; Gertler et al., 2004). The roots of this intergenerational dependence may be different styles of upbringing between high- and low-educated parents, or ability, which is usually higher among high-educated individuals than among low-educated individuals (Becker, 1993; Griliches and Mason, 1972; Mincer, 1958).

Unobserved school-level heterogeneity, such as teacher quality or ethos, could similarly be correlated with both deprivation and school performance. As these differences are unobservable and consequently omitted from the regression, an identification of the effect of deprivation is likely to be biased in simple Ordinary Least Square (OLS) regressions. The usual way to deal with omitted variable bias is to instrument the endogenous variable with one or more variables that are correlated with the endogenous variable and uncorrelated with the error term (Angrist and Pischke, 2009). We can write the basic relationship we are interested in as a hierarchical model

$$APR_{ijt} = \beta_0 + \beta_1 MDM_j + \beta_2 X_{it} + \beta_3 Z_{jt} + u_i + v_j + \epsilon_{ijt}, \tag{1}$$

where i is the subscript for individual schools, j is the subscript for electoral wards, t is a subscript for years, APR is average pass rates, MDM is the multiple deprivation measure, which is endogenous, X and Z are vectors of exogenous regressors at the school and electoral ward level, respectively, u is school unobserved heterogeneity, v is electoral ward unobserved heterogeneity, β's are regression coefficients and ϵ is the error term. If u and v were observable, the error term would be uncorrelated with the regressors. Since we cannot observe u, the OLS coefficient of MDM is inconsistent and biased, because $COV(u_i, \epsilon_i) \neq 0$.

Following an instrumental variable approach, we regress the endogenous variable MDM on all exogenous regressors X, Z and instruments IV:

$$MDM_j = \alpha_0 + \alpha_1 X_{it} + \alpha_2 Z_{jt} + \alpha_3 IV_j + \eta_j \tag{2}$$

where α are regression coefficients and η is the error term. For IV to be valid instruments they must be partially correlated with MDM, i.e. $\alpha_3 \neq 0$, and they must be uncorrelated with the error term ϵ , i.e. $COV(IV, \epsilon) = 0$ (Wooldridge, 2002).

In an extended analysis, the causal effect of each single domains on school APR is identified by estimating separate models for each. In these models we include a multiple deprivation measure consisting of the remaining domains, raising the concern of two potentially endogenous variables. By generating two instruments (deaths and the spatial lag of deaths), we are able to present a just-identified analysis of this relationship. We believe historical violence to be a valid instrument as the NIMDM comprises a range of domains that could be related to historical violence. These domains, however, also capture any other effects of historical violence on contemporaneous school performance. Due to potential collinearity between the two instruments, which would not allow us to identify a causal effect in the just-identified case, we use the third polynomial of the *deaths* variable. Model statistics show that this is a valid transformation of the instruments.

We are concerned with another potential bias which is rooted in selection of families into or out of deprived neighbourhoods. It has been shown that with increasing conflict intensity, house prices increased in less violent neighbourhoods as people moved away from high-violence areas (Besley and Mueller, 2012). Selection is likely to be determined by financial means, causing increased deprivation in conflict areas, as relatively rich people move away. If we presume that selection varies by school catchment area, denoted by u_i in Equation 1, our instruments would account for this type of selection bias.

However, if families do not select into school catchment areas but select into wards (which are greater in size than school catchment areas), the instrumentation could not account for this potential bias. In fact, school catchment areas are not enforced and parents can enrol their children in any primary school, unless a school is over-subscribed (BBC Learning – Parents: Support your child's education, 2013). This reduces the incentive for parents to move into a certain school catchment area. Rather, parents may choose their place to live on a lower level of regional disaggregation, such as ward level.

Selection into wards can be seen as a 'random effect', which is represented by v_j in Equation 1. To avoid this potential bias in our estimated coefficients, we estimate a random effects two-stage least squares model (RE2SLS). This model is explained in Balestra and Varadharajan-Krishnakumar (1987). It allows for a more general error structure than is required for consistency in the 2SLS estimation. Clarke et al. (2010) discuss the usefulness of estimating random effects models in education research. Although their smallest unit of observation are pupils and the second level of analysis are schools, the modelling strategy can easily be 'up-scaled' in the sense that our unit of observation are schools and the second level are electoral wards. Clarke et al. state that, apart from the strong and often unrealistic assumption of independence between the 'random (second level of

analysis) effects' and the other regressors, the random effects approach is preferable over the fixed effects approach.

We also estimate an error-component two-stage least squares model (EC2SLS) proposed by Baltagi (1981). The EC2SLS model is essentially an extension of the Balestra and Varadharajan-Krishnakumar (1987) model but uses a larger set of instruments. While RE2SLS uses the the GLS transformed instruments X, Z, in EC2SLS both the within-transformed instruments, $\widetilde{Z}$, and the between-transformed instruments $\overline{Z}$ are used. Accordingly, EC2SLS uses up to double the number of instruments and is shown to be more efficient in small samples (Baltagi and Liu, 2009). Baltagi (2008) provides more technical details of the methods[7].

5 Results

5.1 Multiple Deprivation

Our results link contemporaneous spatial differences in multiple deprivation to the intensity of historical violence, although we are agnostic on attributing causality to this relationship. Indeed, it seems highly probable that both are interlinked. In Column 1 of Table 3, the results from the 'first stage' regressions[8], it is shown that the number of historical deaths in a region is a positive and accurate predictor of current deprivation. Although these effects are not large in magnitude, they are shown to be strong enough to identify a causal relationship in the second stage of our regression[9].

The OLS estimates identified in Column 2 of Table 3 are immediately suggestive of the negative impact of deprivation on the probability of attaining the minimum Key Stage II pass. In this model, a one standard deviation increase in the NIMDM score is associated with a 1.5 percentage points drop in children attaining the minimum criteria. This effect increases to almost 2.5 percentage points (Column 3) when we follow a random effects approach, which accounts for specific ward unobservables. We see further increases in magnitude when we adopt two-stage approaches, with effects suggesting a drop of almost 4.8 percentage points, due to a marginal increase in the level of regional deprivation, as shown in Columns 4, 5 and 6 of Table 3. In different terms, this means an increase by one unit of the MDM score reduces APR by approximately 1.4 percentage points, as one standard deviation of MDM before standardising is 3.4. Due to the treatment of instruments and the increased efficiency of the outputs, we favour EC2SLS and base our discussion on these outcomes, although the coefficients from 2SLS and RE2SLS are of

[7]The RE2SLS and EC2SLS models are calculated using xtivreg3 (Schaffer, 2013) in Stata

[8]These 'first stage' outputs are simple OLS regressions of the MDM score on the total number of deaths (the third polynomial divided by 1,000 and the other control variables.

[9]The Cragg-Donald Wald F Statistic identifies that the instrument is strong, passing the Stock-Yogo thresholds at 5%.

comparable scale and support such findings.

Table 3: Base Results

	First Stage MDM Score[1]	Second Stage Average Pass Rate[1]				
	1 OLS	2 OLS	3 RE	4 2SLS	5 RE2SLS	6 EC2SLS
Deaths[3]	0.004***	–	–	–	–	–
	(0.001)					
Multiple DM	–	-1.525***	-2.432***	-3.388	-4.461**	-4.794***
		(0.434)	(0.346)	(2.149)	(1.927)	(0.579)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
N	5937	5937	5937	5937	5937	5937
R^2	0.559	0.252		0.243	0.938	0.938
R^2 centered				0.243	0.331	0.330
R^2 overall			0.245			
χ^2			966			
F	24	30		30	3208	3203
p	0.000	0.000	0.000	.	0.000	0.000
CD Wald F				133	205	68
Sargan statistic				0	0	56
Sargan χ^2-p						0.000

Note: [1] Dependent variable. OLS = Ordinary Least Squares, RE = Random Effects, 2SLS = Two-Stage Least Squares, RE2SLS = Random Effects Two-Stage Least Squares, EC2SLS = Error Component Two-Stage Least Squares. CD = Cragg-Donald Wald F statistic for weak instrument identification test. Standard errors in parentheses. Standard errors are clustered at Ward level in OLS, RE and 2SLS models and based on the the GLS variance estimator in the RE2SLS and EC2SLS models. *,** and *** denote significance level of 10%, 5% and 1%, respectively.

Comparison of the coefficients between our one-stage and two-stage analyses suggests that the direction of bias is towards zero, which appears to contradict the traditional theory of "ability". In these suggestions, two potentially reinforcing effects may occur; firstly, that there is a direct causal impact of deprivation on education outcomes and, secondly, deprivation may also be correlated with unobservables such as the average ability of those who live in a neighbourhood. Those with the greatest ability are those most likely to move away from deprived areas, resulting in a non-causal relationship between ability and outcomes, leading to a larger coefficient, biased away from zero, than in the true relationship. Despite this history, however, we do not find a bias towards zero surprising or unexplainable.

Firstly, we focus on a significantly wider definition of deprivation than features in the literature. The typical explanations for bias, therefore, are not entirely relevant to our measure. The potential link between ability, income and deprivation, for example, would play less of a role in our analysis than in most. By contrast, the link between ability and the road distance to a GP, dentist, optician or accident and emergency room, as accounted for in our Proximity to Services domain seems significantly less clear-cut. Our Health domain measure, similarly, focuses on issues such as mental health and cancer rates, which, again does not seem intrinsically linked to ability.

For this reason, we have remained agnostic on the direction of bias throughout our discussion. In our MDM measure it is implied that a financially deprived ward with good

access to services and a comparatively wealthy ward in the countryside, and therefore distant from services, could be equally deprived, but that they are deprived in different ways. Whilst we observe a statistically significant difference in the parent teacher ratio, with schools in more deprived areas exhibiting more teachers per pupil, other such direct interventions may be unobservable. In the UK, such policies include active funding streams based on deprivation, for example[10], such as the Early Years Entitlement, which we do not observe. The nature of our bias would suggest that such initiatives are effective in mitigating the impacts of regional deprivation on school-level achievement but cannot eliminate the problem.

We conduct a series of robustness checks by altering the form of our first instrument. In this baseline analysis, we use the third order polynomial of deaths but results are shown to be robust to other levels of polynomial, to deaths per 1,000 inhabitants (using the 2001 census) and a series of dummy variables that take the value of one if a threshold of violence is reached (1 death, 5 deaths and 10 deaths) and zero if not[11]. In the appendix we provide the results from the base regressions including both the third order polynomial and the spatial lag of deaths as instruments. This table A2 also shows the other coefficients which do not differ to the coefficients in Table 3.

5.2 Single Deprivation Domains

That there is a link between deprivation and children's schooling outcomes is uncontroversial and should come as no surprise. Despite such uncontroversial findings, however, significant debate has taken place in the literature, particularly regarding the role of financial deprivation on human capital accumulation. In this section, we attempt to shed further light on these outcomes by analysing each of the domains separately. Practically, we treat both the single domain and an unweighted sum of the remaining domains as endogenous by introducing the spatial lag of deaths as our second instrument. These results are displayed in Table 4. In these specifications, we repeat our earlier analysis on the multiple deprivation measure. As robustness checks, we also include a weighted measure of the remaining MDM measures and use different polynomials of our instruments. As before, our findings are robust across a majority of our models, although in the just-identified 2SLS and RE2SLS models, there is some effect from multicollinearity. The results from these models are provided in Table A3. Appendix table A1 further shows the conditional correlation between the instruments and all deprivation domains.

The most noticeable result presented in this section shows that neither the income domain, nor the employment domain, are shown to have any impact on educational achievement when other sources of deprivation are accounted for. Despite this finding,

[10] http://www.education.gov.uk/schools/adminandfinance/financialmanagement/schoolsrevenuefunding/archive/a0014385/school-funding-deprivation-indicator

[11] These results can be obtained from the corresponding author on request

Table 4: Single Deprivation Measure: EC2SLS Results

	Deprivation Measure						
	Income	Empl.	Education	Health	Liv.Env.	Prox.Serv.	Crime
Single indicator	-0.882	-0.353	-2.380**	0.409	-0.010	0.323	-3.308***
	(1.718)	(1.840)	(1.010)	(2.271)	(1.434)	(1.334)	(1.230)
MDM w/o indicator	-4.565***	-5.024***	-3.477***	-5.666***	-5.456***	-5.516***	-3.300***
	(1.618)	(1.725)	(1.239)	(1.931)	(1.129)	(0.997)	(0.913)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5937	5937	5937	5937	5937	5937	5937
R^2 centered	0.322	0.322	0.322	0.321	0.322	0.324	0.310
F	2719	2723	2676	2699	2728	2883	2248
p	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CD Wald F	16	11	16	5	8	14	14
Sargan statistic	51	51	51	51	50	53	44
Sargan χ^2-p	0.001	0.001	0.001	0.001	0.001	0.001	0.007

Note: *Dependent variable. OLS = Ordinary Least Squares, RE = Random Effects, 2SLS = Two-Stage Least Squares, RE2SLS = Random Effects Two-Stage Least Squares, EC2SLS = Error Component Two-Stage Least Squares. CD = Cragg-Donald Wald F statistic for weak instrument identification test. Standard errors in parentheses. Standard errors are clustered at Ward level in OLS, RE and 2SLS models and based on the the GLS variance estimator in the RE2SLS and EC2SLS models. *,** and *** denote significance level of 10%, 5% and 1%, respectively.

however, the sum of the other domains is shown to be significant, suggesting that deprivation has associated negative impacts on educational outcomes, although financial deprivation, alone, does not. Not only does this stand in direct contrast to the suggestions of much of the literature, it is also provides a rationale for the mixed results in the financial deprivation literature.

We propose, therefore, that any research that aims to study the impact of deprivation using, solely, financial deprivation runs one of two risks of increasing severity. The first of these risks is an identification problem, where financial deprivation is inferred to cause worse outcomes, rather than acting as a proxy for wider deprivation. In such situations, policy recommendations seem likely to be misdirected towards improving regional economic performance, rather than the other underlying drivers of deprivation, which actually cause the adverse outcomes. The second occurs in situations where financial deprivation may not even be an accurate proxy of deprivation; in such cases, conclusions suggesting that deprivation does not cause adverse outcomes at all may lead to policy inaction and a sustention of the negative impacts of deprivation.

In all seven of these analyses, the 'remainder' of the multi-deprivation measure is shown to be a negative and significant driver of adverse educational outcomes, with the negative impacts shown, once more to be, approximately, five percentage points for a one standard deviation increase in multiple deprivation. Over and above this 'remainder', however, only the education and crime domains are shown to have impacts. An increase in the education deprivation domain by one standard deviation is shown to lead to a lower APR of 2.4 percentage points, holding the multiple deprivation domain and all other regressors constant. The multiple deprivation domain, in this case, reduces APR

by 3.5 percentage points, when increased by one standard deviation and holding all other regressors constant. A linear combination of these two coefficients approximates to the coefficient shown in Chapter 5.1, when only multiple deprivation is included. This also holds for the crime domain where the linear combination of the coefficients is slightly larger but not statistically different from the education case.

The immediate suggestion that educational deprivation causes poorer educational outcomes might seem self-evident but the research presented in this paper deals with an assessment of the ages between 9 to 11, whilst the 2005 education deprivation domain pertains only to education of students older than 14. The literature shows, however, strong intergenerational transfer of parents' educational outcomes. Accordingly, parents affected by poor post-primary education in a region are likely to transfer these poor outcomes to their children and to the performance of local primary schools, in the longer term. From this we infer that our education domain depicts the aggregate level of parents' education and is therefore, logically, a significant driver of primary school outcomes. This domain includes a measure of the prevalence of attainment of the adult population in each location, including the percentage of individuals without any qualifications or skills, supporting the above notion.

The crime domain measure is broad, including acts from arson to property damage. We propose, therefore, that the impact of crime is likely to be a combination of supply- and demand-side issues. On the demand side, we think of a potentially damaging impact of engagement on low-level criminal activity. This may include access to harmful substances, for example; or incentives for truancy or engagement in anti-social behaviour and so forth. On the supply side we propose higher local crime rates result in property damage to schools and increased numbers of lost school, which have an obvious direct impact on the potential of that school to do well.

5.3 Discussion

Whilst our results provide strong evidence on the role of deprivation in the determination of primary school outcomes, the specific historical context of conflict in Northern Ireland adds further concern to these findings. That the regions that were most affected by "The Troubles" remain the most deprived is suggestive of significant regional horizontal inequalities, which are commonly cited as a cause of the violence (see Fitzduff and O'Hagan, 2009; Honaker, 2010). This suggests that, in Northern Ireland, there is a two-fold role for counter-deprivation policies; firstly, they help increase social mobility and reduce the disadvantage of outcomes associated with growing up in deprived regions and secondly, they become an important instrument for the continuing peace process in

the state[12].

The link between primary school performance and later life outcomes suggest that those who grow up in the most deprived regions are those who can expect the poorest life outcomes. Given the predominance of young people involved in on-going inter-community street violence in Northern Ireland and that such disturbances occur, predominantly in comparative deprived regions, continued deprivation must be seen as a contributory factor to an undesirable but common feature of life in Northern Ireland. Until suitable policies are implemented to reduce the enduring post-conflict deprivation, it seems likely that such disturbances will remain common.

We propose, both in Northern Ireland and elsewhere, that a narrow policy focus, however, will be unsuccessful in delivering aims of improving life-time outcomes for those affected by deprivation. Financial policies, such as direct welfare transfers, seem unlikely to improve education or social mobility, yet are commonly relied upon by governments. Instead, a wider approach to combating deprivation, which focuses on the quality of local schools, improved access to services and social networks, that aim to improve parental health and that aim to minimise crime are all required to improve primary school performance and in breaking the cycle of long-term regional deprivation.

6 Conclusion

The important link between human capital accumulation and future labour market outcomes has been well-established in the literature. By extension, human capital accumulation itself can become an important anti-poverty device. Over and above a reflection of innate abilities, however, a growing body of literature has sought to find the role of exposure to deprivation, both individually and in neighbourhoods, on human capital accumulation. The impacts of living in deprived neighbourhoods has been shown to impact on individual outcomes (e.g. Weinhardt, 2010; Oreopolous, 2003; Jacob, 2004; Durlauf, 1996; Gibbons, 2002; Bauer et al., 2011).

Despite this work, finding a suitable measurement of deprivation is difficult and the role of neighbourhood effects are not well understood, suggesting potential issues with identification of causal relationships. In this paper, we aim to overcome these outstanding issues. Following the suggestion of Gibbons (2002), we employ a measure which focuses on several domains of deprivation. Our measure, Northern Ireland's multiple deprivation measure includes; income deprivation, employment deprivation, health deprivation and

[12]We looked at descriptive statistics (not shown), which compares two samples; a Catholic primary school sample and a non-Catholic primary school sample. Catholic primary schools, typically, are located in areas that experienced higher conflict intensity than non-Catholic schools, whilst there are also higher levels of FSME and deprivation in the areas in which Catholic schools are situated. Despite these differences, however, contemporary crime, average pass rates and other school indicators do not differ due a school's religious designation.

disability, education, skills and training deprivation, proximity to services deprivation, living environment deprivation and crime and disorder. Using a weighted average of these domains, we estimate the effect of multiple deprivation on the proportion of primary school children meeting or exceeding the minimum acceptable standard in the Key Stage II exams in Northern Ireland. We overcome any potential endogeneity by introducing historical violence in Northern Ireland as an instrument for our deprivation measure.

Our results shed new light on the causal impact of deprivation on school-level outcomes by showing only indirect effects of financial and employment deprivation. In both situations, these measures are shown to be insignificant determinants of outcomes when other sources of deprivation are accounted for. This contrasts significantly with a literature that has, broadly, sought to measure deprivation through a series of financial proxies. Furthermore, it suggests that any attempt to tackle the adverse outcomes associated with deprivation will fail if they focus, only, on individual or local economic factors. These findings also suggest the potential pitfall inherent in the literature's, hitherto, over-reliance on financially-based proxies for regional deprivation. In many cases, as in this paper, financial deprivation is strongly correlated with net regional deprivation but this is not inherently the case. Indeed, even in situations such as ours, causal identification is lacking if there is a focus, only, on financial deprivation. We further show that the role of deprivation occurs through the channels of education deprivation and crime deprivation, both showing a significant adverse impact on primary school performance over and above an index of the remaining domains. Accordingly, policies must focus on improving general neighbourhood characteristics, rather than simply neighbourhood income or employment opportunities.

Northern Ireland is an interesting test case as regional and horizontal inequalities have been prevalent since the creation of the country in 1921. The history of the country, also, serves as an important feature in facilitating this study. Northern Ireland suffered a long-run, low-intensity conflict, in which nearly 3,600 individuals lost their lives in a series of terrorist attacks. Whilst cultural identity and nationalism played important roles in this conflict, the real and perceived horizontal inequalities between the Protestant and Catholic communities are frequently cited as causes of the conflict (Fitzduff and O'Hagan, 2009) and as drivers of the intensity of violence (Honaker, 2010).

The results not only show that violent conflict is associated with long-term deprivation but that it also has long-term implications for children who were born following the conflict. Persisting regional inequalities, therefore, are not only a barrier to social mobility but also an obstacle for a continued peace process. The endurance of these effects suggests that governments have, hitherto, failed to address these issues which, in the specific context of Northern Ireland appears to have two potentially reinforcing negative effects. Firstly, that it reduces the expected life outcomes of those living in deprived

neighbourhoods and, secondly, that it facilitates the ongoing, low-level street disturbances that frequently occur between Northern Ireland's rival communities. That these street disturbances could further sustain regional deprivation suggests the urgent requirement for suitable policy interventions that tackle the full array of deprivation domains.

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Appendix

Table A1

	Deprivation Measures								
	Multiple	Multiple	Income	Empl.	Education	Health	Liv.Env.	Prox.Serv.	Crime
Deaths[3]	0.004***	0.003***	0.005***	0.004***	0.004***	0.003***	-0.001	0.001	0.001
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Spatial Lag Deaths	–	0.063***	0.036***	0.038**	0.056***	0.046***	0.056***	0.062***	0.041**
		(0.016)	(0.013)	(0.015)	(0.019)	(0.012)	(0.015)	(0.011)	(0.016)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5937	5937	5937	5937	5937	5937	5937	5937	5937
R^2	0.559	0.593	0.679	0.600	0.529	0.501	0.397	0.637	0.477
F	24	26	39	28	18	24	15	39	17
p	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: Ordinary Least Squares regressons with clustered standard errors (Ward level). Standard errors in parentheses. *,** and *** denote significance level of 10%, 5% and 1%, respectively.

Table A2: Base Results - Two instruments

	First Stage MDM Score[1]	Second Stage Average Pass Rate[1]				
	1 OLS	2 OLS	3 RE	4 2SLS	5 RE2SLS	6 EC2SLS
Deaths[3]	0.003***	–	–	–	–	–
	(0.001)					
Spatial Lag Deaths	0.063***	–	–	–	–	–
	(0.016)					
Multiple DM	–	-1.525***	-2.432***	-5.194***	-5.528***	-4.970***
		(0.434)	(0.346)	(1.110)	(0.949)	(0.573)
Total enrolment	0.001**	0.017***	0.013***	0.020***	0.015***	0.015***
	(0.000)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Number of Pupils	-0.004	-0.229***	-0.213***	-0.235***	-0.209***	-0.210***
	(0.003)	(0.038)	(0.033)	(0.041)	(0.033)	(0.033)
Number of Pupils sqrd.	0.000	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Pupil-teacher ratio	-0.007	-1.441**	-0.609	-1.464**	-0.580	-0.313
	(0.067)	(0.635)	(0.438)	(0.662)	(0.441)	(0.465)
Pupil-teacher ratio sqrd.	0.000	0.041***	0.018	0.041**	0.016	0.010
	(0.002)	(0.016)	(0.011)	(0.016)	(0.011)	(0.012)
Gaelic exams	-0.015	5.596***	2.934*	5.889***	3.282**	3.332**
	(0.181)	(1.967)	(1.498)	(2.206)	(1.543)	(1.540)
Catholic School	-0.046	1.342**	1.300**	1.174*	1.233*	1.227*
	(0.064)	(0.550)	(0.619)	(0.604)	(0.661)	(0.666)
Free School Meal 10-20%	0.289***	-2.791***	-2.055***	-1.745***	-1.383***	-1.450***
	(0.041)	(0.526)	(0.444)	(0.618)	(0.482)	(0.459)
Free School Meal 20-40%	0.742***	-6.346***	-4.855***	-3.514***	-3.152***	-3.341***
	(0.065)	(0.714)	(0.578)	(1.088)	(0.743)	(0.635)
Free School Meal > 40%	1.475***	-14.455***	-10.312***	-8.162***	-6.236***	-6.681***
	(0.142)	(1.319)	(0.912)	(2.225)	(1.415)	(1.082)
Catholic inhabitants (%)	-0.002	0.013	0.014	0.007	0.017	0.015
	(0.002)	(0.012)	(0.011)	(0.014)	(0.012)	(0.012)
All Persons 0-15	0.001***	-0.000	-0.001	0.004	0.001	0.000
	(0.000)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
All Persons 16-39	0.000	-0.001	-0.000	0.000	0.000	0.000
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
All Persons 40-59/64	-0.003***	0.001	0.002	-0.009**	-0.004	-0.003
	(0.000)	(0.003)	(0.002)	(0.004)	(0.003)	(0.002)
All Persons 60/65+	0.001**	-0.004	-0.004*	0.004	0.001	-0.000
	(0.001)	(0.003)	(0.002)	(0.004)	(0.003)	(0.003)
Bombing incidents	-0.003*	0.041*	0.028	0.017	0.022	0.023
	(0.002)	(0.023)	(0.020)	(0.024)	(0.020)	(0.020)
Shooting incidents	0.007**	-0.030	-0.012	0.026	0.005	0.004
	(0.003)	(0.026)	(0.023)	(0.027)	(0.023)	(0.023)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes
N	5937	5937	5937	5937	5937	5937
R^2	0.593	0.252		0.217	0.933	0.933
R^2 overall			0.245			
χ^2			966			
F	26	30		28	2948	2960
p	0.000	0.000	0.000	.	0.000	0.000
CD Wald F				317	513	77
Sargan statistic				1	0	55
Sargan χ^2-p				0.323	0.556	0.001

Note: [1] Dependent variable. OLS = Ordinary Least Squares, RE = Random Effects, 2SLS = Two-Stage Least Squares, RE2SLS = Random Effects Two-Stage Least Squares, EC2SLS = Error Component Two-Stage Least Squares. CD = Cragg-Donald Wald F statistic for weak instrument identification test. Standard errors in parentheses. Standard errors are clustered at Ward level in OLS, RE and 2SLS models and based on the the GLS variance estimator in the RE2SLS and EC2SLS models. *,** and *** denote significance level of 10%, 5% and 1%, respectively.

Table A3: Single Deprivation Measures

	Dependent Variable: Average Pass Rate			
	1 OLS	2 RE	3 2SLS	4 RE2SLS
Income DM	1.114*	0.328	0.412	-0.166
	(0.649)	(0.594)	(2.269)	(2.718)
MDM w/o income	-2.153***	-2.601***	-5.869**	-5.614**
	(0.589)	(0.534)	(2.410)	(2.335)
Controls	Yes	Yes	Yes	Yes
R-squared	0.253	0.245	0.208	0.320
CD Wald-F			175	172
Employment DM	0.639	-0.010	0.564	-0.207
	(0.573)	(0.529)	(2.989)	(3.669)
MDM w/o empl.	-1.880***	-2.375***	-5.974**	-5.582*
	(0.594)	(0.514)	(2.847)	(3.029)
Controls	Yes	Yes	Yes	Yes
R-squared	0.252	0.245	0.208	0.320
CD Wald-F			82	74
Education DM	-1.041**	-1.626***	-1.885	-2.542
	(0.438)	(0.387)	(2.225)	(2.628)
MDM w/o educ.	-0.632	-1.054***	-4.320	-3.786
	(0.443)	(0.409)	(3.050)	(2.902)
Controls	Yes	Yes	Yes	Yes
R-squared	0.252	0.245	0.204	0.320
CD Wald-F			50	60
Health DM	-0.327	-0.576	0.780	-0.483
	(0.447)	(0.449)	(4.675)	(6.879)
MDM w/o health	-1.237**	-1.977***	-6.202	-5.339
	(0.499)	(0.467)	(4.363)	(5.965)
Controls	Yes	Yes	Yes	Yes
R-squared	0.252	0.245	0.203	0.320
CD Wald-F			23	15
Liv.Env. DM	-0.347	-0.381	-2.422	-2.422
	(0.392)	(0.347)	(3.396)	(4.084)
MDM w/o liv.env.	-1.265**	-2.219***	-3.901	-4.710
	(0.495)	(0.393)	(2.658)	(3.036)
Controls	Yes	Yes	Yes	Yes
R-squared	0.252	0.245	0.206	0.321
CD Wald-F			27	24
Prox.Serv. DM	-0.485	-0.668	-1.720	0.243
	(0.438)	(0.437)	(7.524)	(7.658)
MDM w/o prox.serv.	-1.265***	-2.088***	-4.017	-5.991
	(0.469)	(0.394)	(6.692)	(6.899)
Controls	Yes	Yes	Yes	Yes
R-squared	0.252	0.245	0.222	0.321
CD Wald-F			5	8
Crime DM	-0.522	-1.005***	-4.572	-2.248
	(0.369)	(0.357)	(10.449)	(9.034)
MDM w/o crime	-1.184***	-1.797***	-2.782	-4.469
	(0.384)	(0.348)	(5.819)	(6.642)
Controls	Yes	Yes	Yes	Yes
R-squared	0.252	0.245	0.186	0.309
CD Wald-F			3	5

Note: OLS = Ordinary Least Squares, RE = Random Effects, 2SLS = Two-Stage Least Squares, RE2SLS = Random Effects Two-Stage Least Squares. CD = Cragg-Donald Wald F statistic for weak instrument identification test. Standard errors in parentheses. Standard errors are clustered at Ward level in OLS, RE and 2SLS models and based on the the GLS variance estimator in the RE2SLS. *,** and *** denote significance level of 10%, 5% and 1%, respectively.

Table A4: Northern Ireland Multiple Deprivation Measure 2005

Sub-Domain	Indicators
Income deprivation	Income Support households; Job Seeker's Allowance households; Working Families' Tax Credit households; Disabled Person's Tax Credit households
Employment deprivation	Unemployment claimant count of women aged 18-59 and men aged 18-64 averaged over 4 quarters; Incapacity Benefit claimants women aged 18-59 and men aged 18-64; Severe Disablement Allowance claimants women aged 18-59 and men aged 18-64; Participants in New Deal for Young People (18-24 years) who are not included in the claimant count; Participants in New Deal for 25+ who are not included in the claimant count; Invalid Care Allowance claimants women aged 18-59 and men aged 18-64
Education deprivation	GCSE/GNVQ points score; Key Stage 3 data; Proportions of those leaving school aged 16 and not entering Further Education; Absenteeism at secondary level (all absences); Proportions of 17-20 year olds who have not successfully applied for Higher Education; Proportions of Years 11 and 12 pupils not in a grammar school; Proportions of post primary pupils with Special Educational Needs in mainstream schools
Health deprivation	Years of Potential Life Lost; Comparative Illness and Disability Ratio; A combined measure of two indicators (i) individuals suffering from mood or anxiety disorders, based on prescribing and (ii) suicides; People registered as having cancer (excluding non-melanoma skin cancers)
Living environment deprivation	SOA level housing stress; Houses without central heating; Household overcrowding; LGD level rate of acceptances under the homelessness provisions of the Housing (Northern Ireland) Order 1988 and the Housing (Northern Ireland) Order 2003, assigned to the constituent SOAs; SOA level local area problem score
Proximity to services deprivation	Road distance to a GP premises; Road distance to an Accident and Emergency hospital; Road distance to a dentist; Road distance to an optician; Road distance to a pharmacist; Road distance to a Job Centre or Jobs and Benefit office; Road distance to a Post Office; Road distance to a food shop; Road distance to the centre of a settlement of 10,000 or more people
Crime and disorder deprivation	Violence, robbery and public order; Burglary; Vehicle theft; Criminal damage; Malicious and deliberate primary fires; Disturbances

Note: A more detailed description can be found at NISRA (2005).