Estimating the Peace Dividend: The Impact of Violence on House Prices in Northern Ireland Estimating the Peace Dividend

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Web Appendix

A Variable Description

Appendix Table 1 gives the summary statistics of the used and generated data. This sections will describe each of the variables in detail.

Appendix Table 1: Summary Statistics

data		Mean	Std. Deviation	Min	Max
	houseprice	77932.20	58232.40	23222.00	292931.00
	number of deaths	0.91	2.35	0	29.00
	unemployment count	6009.42	5353.39	1000.33	34696.67
	housing starts	209.88	116.07	19.50	1078.00
	population	143439.60	67169.43	72033.00	340036.00
	pounds	25.72	18.86	6.40	102.00
	deaths in Israeli conflict	210.57	127.63	27.00	528.00
	T-25 stock market index	489.17	125.80	321.54	790.48
constructed variables					
Region Specific	present value (r = 5%) see equation 2	19.29	23.97	1.90	112.10
	present value (r = 1%) see equation 2	91.93	109.51	9.36	440.36
Single Index	present value (r = 5%) see equation 2	18.49	24.84	1.30	112.42

Houseprice: We use the house price index provided by the University of Ulster in cooperation with the Bank of Ireland and the Northern Ireland Housing Price Executive. The project surveys more than a thousand open market housing transactions every quarter. Data is provided for eleven regions starting from October 1984 until today (with the exception of a few quarters for which no reports could be found in the UK or Ireland). Our data-set uses the average overall housing price in a region and does not differentiate by housing type.

In our robustness checks we also use data from quarterly houseprice data available from Nationwide Building Society on the UK regions North West, Yorkshire, East Midlands and Wales.

Number of Deaths: This variable relies on data from the Conflict Archive on the Internet (CAIN) website which presents updated work by Sutton (1994) who recorded the details of every killing arising from the present conflict in Ireland from newspaper cuttings, funerals, court records, cemeteries and books

and pamphlets. The book gives the date of the killing of every victim, the name, his or her age, their 'status' in relation to the conflict, which organization killed them, and a brief description of the circumstances of their death. In addition, the data set provides an almost exact address which allows us to match this to the house price data. For example:

Example

25 January 1989	David Dornan (26) Protestant Status: Civilian (Civ)	Killed by: Ulster Freedom Fighters
	Shot at his workplace, building site, Kingsmore Link Road, Lisburn, County Antrim. Assumed to have been a Catholic.	

Population: The population and religion mix comes from the 1991 Census, Census Office for Northern Ireland. The data is by district council so that it has to be recoded to fit to house price regions. The fit is reasonable except for the district council Strabane which is split into two parts by two Housing Price Regions. As a simplification we treat the population (and unemployed) of Strabane as belonging half to the region Londonderry/Strabane and half to Enniskillen/Fermanagh/South Tyrone.

Recoding

Housing Price Region	Census Districts	Housing Price Region	Census Districts
Belfast	Belfast	Enniskillen/Fermanagh/ S Tyrone	Fermanagh
	Castlereagh		$\frac{1}{2}$ Strabane
North Down	Ards	Mid Ulster	Cookstown
	North Down		Dungannon
Lisburn	Lisburn		Magherafelt
East Antrim	Carrickfergus		Omagh
	Larne	Mid and South Down	Down
	Newtonabbey		Newry and Mourne
Londonderry/Strabane	Derry	Craigavon/Armagh	Armagh
	$\frac{1}{2}$ Strabane		Banbridge
Antrim/Ballymena	Antrim		Craigavon
	Ballymena		
Coleraine/Limavady/N Coast	Ballymoney		
	Coleraine		
	Limavady		
	Moyle		

We have also used population trends between 1991 and 2001 (the two census years) but results have been identical and are therefore not reported.

Unemployment: Monthly unemployment counts are provided by the UK office for National Statistics. We use the 3 month average of the counts for our purposes. Again, unemployment counts are provided for each of the council districts so that we have to recode the data according to the above table. We have also combined this data with constructed population trends to see whether a measure of the unemployment rate would yield different results. This is not the case.

Housing Starts: We use data from District Council Building Control Offices which provide quarterly housing starts for each district in Northern Ireland. Data is available on private, social and housing executive starts. Since private starts are by far the biggest bulk we only include these in our analysis. Again we use the regional recoding from above to match the council data to our houseprice data.

Tourism Data: Regional tourism data on trips, nights and pounds spent is published in "Local Authority Tourism Estimates" reports made available on a yearly basis by the Northern Ireland Tourist Board. These reports present survey based estimates of tourism within Northern Ireland's local authority areas. We recode this data to match the council regions with our houseprice data. An important caveat with this data is that the reported estimates represent a rolling average over the last three years. We present only results on pounds spent - results using trips and nights are identical.

Stock Market Data: Stock market is the closing TA-25 index value from the Tel Aviv Stock Market. Available at http://www.tase.co.il/TASEEng/Homepage.htm

Deaths in the Israeli/Palestinian Conflict: Data is taken from the replication data by Jaeger and Paserman (2008). Available at http://www.e-aer.org/data/sept08/20051054_data.zip. We add Israeli and Palestinian deaths.

B Single Index EM Estimation

Appendix Table 2 reports the derived coefficients of the single index EM estimation. The transition probabilities are the same across regions because only one conflict process is estimated in this case.

Appendix Table 2: Single Index EM Estimation Results

	Mean Deaths per Quarter in Conflict	Mean Deaths per Quarter in Peace	Probability of a Quarter of Conflict following Conflict	Probability of a Quarter of Peace following Peace
Belfast	6.997	1.033	0.970	0.971
North Down	0.187	0.187	0.970	0.971
Lisburn	0.504	0.000	0.970	0.971
East Antrim	0.000	0.000	0.970	0.971
Londonderry/Strabane	1.651	0.000	0.970	0.971
Antrim/Ballymena	0.070	0.070	0.970	0.971
Coleraine/Limavady N Coast	0.213	0.000	0.970	0.971
Enniskillen/Fermanagh/ S Tyrone	1.204	0.000	0.970	0.971
Mid Ulster	2.757	0.000	0.970	0.971
Mid and South Down	2.218	0.000	0.970	0.971
Craigavon/Armagh	1.893	0.000	0.970	0.971

Estimates are obtained through application of the EM Algorithm discussed in Hamilton (1990). *Mean Deaths* are calculated using a second stage OLS regression that regresses regional violence on the EM estimate of the Northern Ireland conflict violence. The table only reports coefficients significant at 10 percent.

If we use the coefficients from table 4 we can translate these estimates into region-specific peace dividends. As can be seen in Appendix Table 3 the results are very similar to those of the region specific model presented in the article.

Appendix Table 3: Economic Significance of Region-Specific EM Model and Linear Regression Estimates

	Present Value Estimates			
	Present Value of Violence (r = 5%) in Conflict	Present Value of Violence (r = 5%) during Peace Time	Impact of Conflict on Houseprices in Percent (95% Confidence Intervall)	
Single Index Conflict Model			**lower bound**	**upper bound**
Belfast	4.52	2.21	4.23	17.16
North Down	0.15	0.15	0.00	0.00
Lisburn	0.33	0.13	0.37	1.49
East Antrim	0.09	0.09	0.00	0.00
Londonderry/Strabane	1.06	0.42	1.17	4.75
Antrim/Ballymena	0.07	0.07	0.00	0.00
Coleraine/Limavady N Coast	0.13	0.05	0.15	0.59
Enniskillen/Fermanagh/ S Tyrone	0.72	0.26	0.84	3.42
Mid Ulster	1.66	0.6	1.94	7.87
Mid and South Down	1.4	0.54	1.58	6.39
Craigavon/Armagh	1.27	0.54	1.34	5.42
Average	1.04	0.46	1.06	4.31
Average (population weights)	1.56	0.71	1.56	6.31

Notes: Present values are normalized by their overall standard deviation. Population weights are by 1991 population from NI census. The SI calculations only use the significant coefficients.

C Use of a Poisson Process

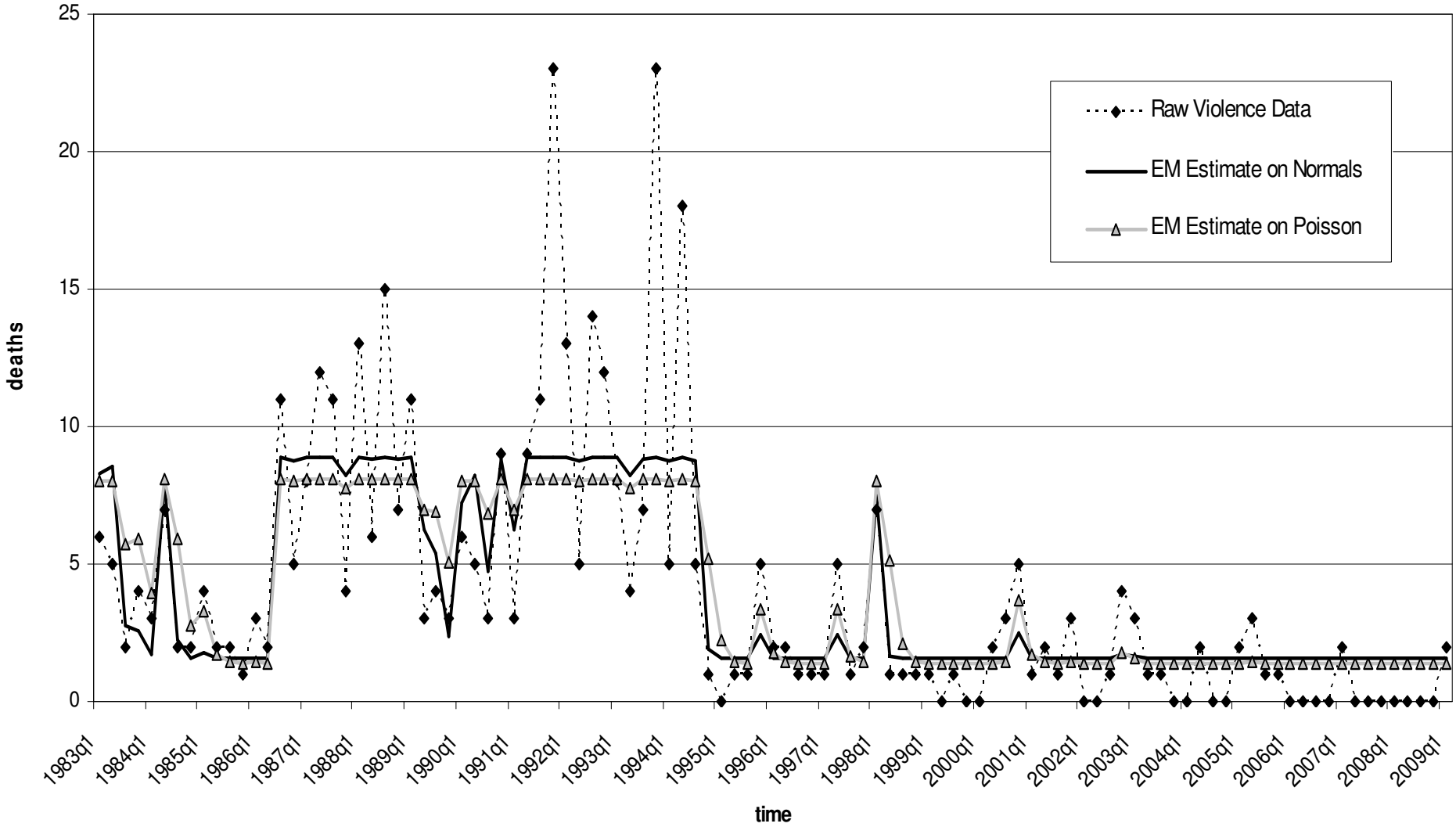
The equation at the bottom of page 16 posits the number of killings as the mean for the current state (conflict or peace) plus a normal disturbance term. The EM algorithm estimates the mean for the states and the state-specific variance terms seperately. However, as can be seen in Table 4 mean and variance generally move together. This makes the use of a Poisson distribution a reasonable simplification. We therefore modified the Gauss programme provided by Hamilton to run the algorithm with this distribution.

Appendix Table 4: EM-Estimates with Variance

Region	Mean Deaths per Quarter in Conflict	Mean Deaths per Quarter in Peace	Probability of a Quarter of Conflict following Conflict	Probability of a Quarter of Peace following Peace	sigma^2 conflict	sigma^2 peace
Belfast	8.11	1.33	0.93	0.96	26.71	1.86
North Down	1.11	0.00	0.27	0.88	0.20	0.01
Lisburn	1.33	0.00	0.29	0.80	1.31	0.01
East Antrim	1.43	0.00	0.07	0.85	1.08	0.01
Londonderry/Strabane	1.81	0.11	0.96	0.96	4.04	0.12
Antrim/Ballymena	0.99	0.00	0.00	0.89	0.11	0.01
Coleraine/Limavady N Coast	1.65	0.00	0.00	0.93	0.98	0.01
Enniskillen/Fermanagh/ S Tyrone	1.69	0.00	0.77	0.88	2.92	0.01
Mid Ulster	3.66	0.00	0.75	0.86	28.15	0.01
Mid and South Down	2.39	0.09	0.97	0.97	4.47	0.10
Craigavon/Armagh	3.27	0.27	0.64	0.84	5.23	0.21

While results are generally very similar (see figure 1 for a comparison of fitted values in Belfast) there are a few problems with implementing this version. In particular, the algorithm had problems fitting the process to the many zeros in

Appendix Figure 1: Comparing Methods - Belfast Quarterly Violence



peaceful regions - we set all of them to zero violence to remedy this.

As can be seen in table 5 our main results are robust to the use of the poisson distribution. The main difference to the estimation with normal distribution is that the lack of degrees of freedom (variance equals mean in the Poisson distribution) leads to higher dispersion and a less good fit.

Appendix Table 5: Estimates with Poisson Distribution

VARIABLES	(1) lnhouseprice	(2) lnhouseprice	(3) lnhouseprice	(4) lnhouseprice
Present Value (5 percent)	-0.0394**	-0.0306**	-0.0399**	-0.0357*
	(0.0146)	(0.0107)	(0.0159)	(0.0171)
Unemployment Rate			-0.163***	
			(0.0447)	
Housing Starts				0.0195**
				(0.00876)
Region Fixed Effects	yes	yes	yes	yes
Time Fixed Effects	yes	yes	yes	yes
Time Trends	no	yes	no	no
Observations	1049	1049	932	924
R-squared	0.988	0.989	0.987	0.986
Number of region	11	11	11	11

Clustered (region) standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

D Parametric Bootstrapping Results

Unlike the standard generated regressor problem, there is no closed-form of θ_r and we do not have a proper variance-covariance matrix of θ_r. This makes the usual two-step error correction difficult. We use the following parametric bootstrapping procedure to estimate the variance that is brought into the present value through our "first stage" estimation of the $\theta's$.

1. We randomly draw 1000 observations of violence by assuming that each observation in the panel is generated by an independent Poisson process with the average for that region and quarter. We chose to generate these observations this way since purely random draws would not create the persistence and kink in 1994 - the two features that drive the peace dividend.

2. This gives us 1000 data sets for each region on which we can run the EM algorithm to generate 1000 estimates of $\hat{\theta}$ - note that we assume a normal distribution of violence around the mean in this step. We do this to be consistent with our original EM estimate and because this way of estimating the EM parameters is more robust (see section C).

3. We take the 1000 $\hat{\theta}_j$'s and "apply" them to the original violence data y_{rt} to generate panels of $\widehat{PDV}_{rt} \mid \hat{\theta}_j$, where $j = 1, ..., 1000$ indicates the bootstrap.

4. We run the original regressions a 1000 times with the generated $\widehat{PDV}_{rt} \mid \hat{\theta}_j$. This generates 1000 estimates of the parameter of interest α_j, $j = 1, ..., 1000$,

i.e. the coefficient on the estimate of $\widehat{PDV}_{rt}$.

5. The standard deviation of these 1000 $\hat{\alpha}_j$'s gives us a good idea about the true error of the estimate $\hat{\alpha}_j$.

We ran all regressions in table 3 and 4 with this method. Generally, the results are robust. The table below shows data on all the regressions we bootstrap.

We calculated the t-stats simply by dividing the original $\hat{\alpha}_j$ by the standard deviation of the 1000 $\hat{\alpha}_j$ draws. As the t-stats indicate all results remain significant at the 5 percent level except for the present value calculated at 1 percent and our results adding the UK regions, both of which are now only significant at 10 percent. Also note that the average alpha coming out of the bootstrapping procedure is not significantly different from the original one. This suggests to us that the first stage generated regressor bias is not particularly important.

Table/Column	Variable	Mean	St. Dev	Original $\hat{\alpha}$	t-stats
(3/1)	$presentvalue(5\%)$	-0.0682	0.0224	-0.0604	2.70
(3/2)	$presentvalue(1\%)$	-0.3636	0.1196	-0.209	1.748
(3/3)	$presentvalue(5\%), lag$	-0.0739	0.0268	-0.0595	2.222
(3/4)	$presentvalue(5\%)$	-0.0611	0.0189	-0.0575	3.041
(3/5)	$presentvalue(5\%)$	-0.0662	0.0201	-0.0601	2.984
(3/6)	$presentvalue(5\%)$	-0.0325	0.0089	-0.0415	4.663
(3/7)	$presentvalue(5\%)$	-0.1889	0.0805	-0.156	1.938
(4/1)	$conflictPV(5\%)$	-0.0394	0.0066	-0.0209	3.157
(4/2)	$presentvalue(5\%)SI$	-0.0513	0.0080	-0.0463	5.809
(4/3)	$presentvalue(5\%)SI$	-0.0393	0.0054	-0.0369	6.783
(4/4)	$presentvalue(5\%)SI$	-0.0293	0.0061	-0.0280	4.583
(4/5)	$presentvaluepc$	-0.0447	0.0084	-0.0436	5.209
(4/6)	$presentvalue(5\%)$	-0.0374	0.0059	-0.0359	6.085
(4/7)	$presentvalue(5\%)$	-0.0627	0.0194	-0.0671	3.461
	$Belfastborder * PV$	0.02408	0.0449	0.0269	5.363
	$LDerry/Strborder * PV$	-0.0225	0.0474	-0.0215	0.454
	$MidUlsterborder * PV$	-0.0144	0.0185	-0.0315	1.705
	$M/SDownborder * PV$	-0.0826	0.0275	-0.0784	2.851
	$Craig/Armborder * PV$	-0.0462	0.0281	-0.0244	0.870