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

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Draft: February 10, 2011

This paper exploits data on the pattern of violence across regions and over time to estimate the impact of the peace process in Northern Ireland on house prices. After establishing a negative correlation between killings and house prices, we estimate the parameters of a Markov switching model with conflict and peace as latent states. We use the model to estimate the size of the peace dividend as captured in house price changes.

JEL: D74, O16, P16

Keywords: Northern Ireland, Conflict, House Prices, Peace Dividend, Markov Chain

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Conflict in Ireland has a long history. Even after the Republic of Ireland was created as an independent state in 1920, the status of the mainly Protestant North remained contested. From the late 1960's a violent conflict flared up which claimed around 3500 lives. Only more than two decades later, from 1993 onwards, emerged a peace process which, while initially fragile, culminated in a cessation of violence and a return to devolved government by 2007. The conflict was a major source of social and economic dislocation. But, as peace took hold, this has begun to be repaired.

This paper assesses the impact of peace by using variation in violence within Northern Ireland to study one important economic aspect of the peace process and the dividend that it brought to residents of Northern Ireland – the impact on house prices. Houses are assets whose prices reflect the present and future expected attractiveness of living in an area. Even during the height of the conflict in Northern Ireland, violence was not uniform. For example, Belfast – the capital city of the province of Northern Ireland – was particularly hard hit. Looking for economic consequences of the peace process, we would therefore expect benefits to be concentrated among areas where violence was most prevalent. We exploit within-region variability in violence and house prices over time. Having such variation is rare in studies of the economic consequences of conflict. Our specific measure of violence is conflict related deaths. These have been well-documented by Sutton (1994) and the Conflict Archive on the Internet (CAIN). Using these data bases, we are able to match the location of the death to a region within Northern Ireland. We then look for a peace dividend in the form of increased house prices in response to a reduction in killing. For this we use a quarterly house price index for 11 regions of Northern Ireland for 1984q1 to 2009q1.

We do not know exactly when peace arrived in Northern Ireland and whether its timing varied across regions of the province. Observed killings are, however, potentially informative about the unobserved state that people care about – peace or conflict. The paper suggests a method for estimating the value of a local amenity whose presence cannot be easily determined but, under some structural assumptions, can be inferred from data. This contrasts with most existing studies of (dis)amenities on house prices. We suppose that citizens were using information about killings to update their views about the likelihood of the peace process holding strong and we estimate the parameters of a Markov process generating transition probabilities across states. These parameters are used to construct an estimate of the expected present discounted value of deaths in each region as a function of the history of killing in that region. The empirical analysis suggests that there are bigger peace dividends in regions of Northern Ireland where violence was more severe and more persistent.

As we will show, our results are robust to a number of methods of estimation. We also find

evidence of spillover effects across regions – violence in Belfast appears to have increased house prices in adjacent areas. This is consistent with the data on relative changes in population over our period of study.

The conflict in Northern Ireland is an important historical event, and gauging the welfare effects of the successful conclusion of this conflict is worthy of study in its own right. But there are wider implications for other long-running conflicts of this sort (i.e., those that involve sustained violence but not all-out warfare) such as those in Israel/Palestine, Iraq, Afghanistan, Chechnya and Spain. Northern Ireland is one of the few modern examples we have from which to draw conclusions about the value of peace and, thus, gauge the welfare cost of living in the midst of a violent conflict. Below, we will draw out some specific lessons from this study for two of these conflicts.

The remainder of the paper is organized as follows. In the next section, we give some background to the Northern Irish conflict. Section I relates our paper to the existing literature. In section II, we discuss data and present some preliminary OLS results. Section III develops a model of house prices and a statistical model of the peace process. We then explain how this can be implemented empirically. Section IV presents results, including a number of robustness checks. Section V looks at implications of the approach for the on-going conflicts in Iraq and for the Israel/Palestine conflicts. Section VI concludes.[1]

I. Background

From the 17th century onwards, the British consolidated their rule over Ireland. However, it was mainly in the nineteenth century that the struggle for reform began. The status of Ireland proved to be a fractious issue in U.K. politics over this century with the issue of Irish home rule splitting the Liberal party at the end of the nineteenth century. Northern Ireland was created after the Government of Ireland Act of 1920 which granted the rest of Ireland independence from the U.K.. Northern Ireland was governed by its own Parliament (Stormont) from 1922 to 1973. However, throughout this period, the long-term status of Northern Ireland remained a contested issue. Within Northern Ireland, a mainly Protestant majority wished to remain part of the U.K. while a large mainly Catholic minority campaigned for unity with the Republic. The Catholic minority in Northern Ireland were also, on the whole, less prosperous than the Protestant majority even though for much of this period, Northern Ireland had higher income per capita than the Republic of Ireland.

The period often referred as the "The Troubles" spans the period from 1969 until the mid 1990s

[1] Further details about the data and estimation methods are in an on-line web Appendix.

and encompasses the main period of conflict studied. A series of events triggered a campaign of violence involving paramilitaries from both sides – frequently referred to as Loyalists and Republicans, the former wishing to remain part of the U.K. and the latter seeking Irish unity. The main paramilitary organization on the Republican side was the Irish Republican Army (IRA). From 1969, British troops were deployed on the streets of Northern Ireland and from 1973, the British government suspended home rule and ran the province directly from Westminster. There were approximately 3500 deaths over this period of which around 1840 were "civilians", around 400 were members of "Republican" paramilitary groups, around 160 were members of "Loyalist" paramilitary groups, and 1100 deaths were deaths of British or Irish security forces.

The Peace Process was initiated on December 15, 1993 when the Prime Ministers of Ireland and the UK signed the "Downing Street Declaration". This affirmed the right of the people of Northern Ireland to self-determination, and that the province would be transferred to the Republic of Ireland from the United Kingdom if and only if a majority of its population was in favour of such a move. It also pledged the governments to seek a peaceful constitutional settlement and promised that parties linked with paramilitaries (such as Sinn Féin) could take part in the talks, so long as they abandoned violence. In response to this, on August 31, 1994, the Irish Republican Army declared a cease-fire.

The next event of major significance was in 1998 when the Belfast Agreement (normally referred to as the Good Friday Agreement) was signed. Its key provisions include affirmation of the principle that any change to the constitutional status of Northern Ireland could only follow a majority vote of its citizens, commitment by all parties to use "exclusively peaceful and democratic means" and establishment of a Northern Ireland Assembly with devolved legislative powers. On June 25,1998, elections to a new Northern Ireland Assembly took place. Following this, on August 15, 1998, the Omagh bombing by a breakaway faction of the IRA killed 29 people leading to concerns about the stability of the peace process. Moreover, between October 14, 2002 – May 7, 2007, the Northern Ireland Assembly was suspended following allegations of spying.

The peace process took a further leap forward in July 28, 2005 when the IRA made a public statement ordering an end to the armed campaign and instructing its members to give up their arms and to pursue purely political means. Following this, on May 8, 2007, home rule was restored following fresh elections to the Northern Ireland Assembly.

There is evidence that the population of Northern Ireland was aware of the positive consequences of the peace process.[2] However, whether the peace process would ultimately be success-

[2]The seventh report of *Social Attitudes in Northern Ireland*, for example, records a positive shift between the 1989 and 1996 surveys in terms of how both Protestants and Catholics saw their relationship. For details see Carmichael and Hughes (1998).

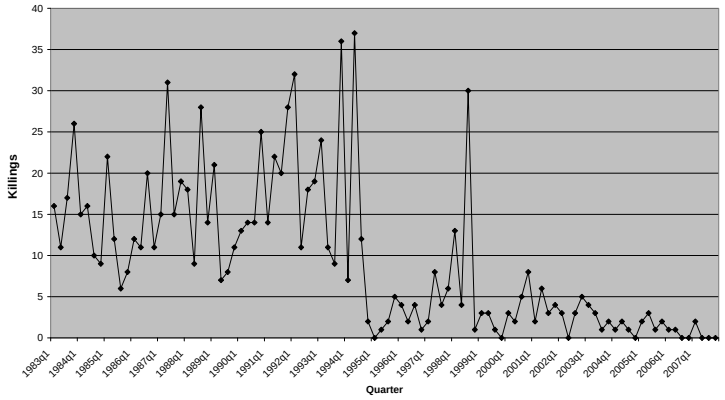


Figure 1: Total Quarterly Killings in Northern Ireland

ful remained uncertain throughout. One of the major issues concerned the decommissioning of weapons and the process of verification that would be needed to create mutual trust.

To get a feel for how successful the peace process was in reducing killing, we produce a graph (Figure 1) on aggregate killings in Northern Ireland over our data period.[3] The rapid fall in violence after the IRA cease fire in 1994q4 is clearly apparent as is the tick up after the Omagh bombing in 1998q3. By and large, the effect of the peace process in the aggregate is clear from Figure 1. Moreover, bombings and shootings data from the Police Service on Northern Ireland (PSNI) confirm the sharp decline in aggregate violent incidents over the same period.[4]

II. Related Literature

This paper is related to a large existing literature that looks at how amenities are capitalized into house prices. One important strand of this literature surveyed by Boyle and Kiel (2001) looks at the impact of environmental externalities on house prices. Their survey suggests rather mixed success in being able to explain differences in house prices by measures of air quality, water quality, land usage and pollutants.

There is also a long tradition of looking at the relationship between school quality and house prices, which is particularly relevant in the U.S. given the extensive use of local property taxes to fund education. Kain and Quigley (1975) is a classic reference in this field. More recently, Black (1999) is an excellent example of how empirical studies of these issues can exploit differences within jurisdictions over time. Using the fact that she can locate people within a district who are

[3] Details on this variable are provided in section IV.

[4] Bombing incidents, for example, dropped from a yearly average of 480 between 1984 and 1994 to 50 incidents in 1995. For yearly statistics on bombings, shootings and incendiaries see http://www.psni.police.uk/.

close to boundaries, she finds that a 5 percent improvement in test scores leads to a 2.5 percent increase in house prices. Her study deals persuasively with the possibility of reverse causation issues that often plague such studies. Figlio and Lucas (2004) consider the impact of public school grades on house prices. They find that schools that persistently receive A grades have large and lasting house price premia.

Turning to dis-amenities, Davis (2004) considers the impact of a leukemia cases on house prices in Nevada and finds that house prices are reduced by a little over 1 percent when there is 1 in 10000 increase in cancer risk. Linden and Rockoff (2008) use the exact location and moving-in date of sex offenders to estimate their impact on housing prices in the immediate proximity of the offender's house. Their results suggest a price decrease of 4 percent of housing in a 0.1 mile radius around the sex offender's home after he/she moved in. Gibbons (2004) uses a cross-section of London property crime data to estimate the impact of these crimes on housing prices. He finds that an increase of one standard deviation in property damage goes hand in hand with a 10 percent drop in property prices.

There are a number of existing studies that look at the link between violence and economic outcomes. In the first study of its kind, Abadie and Gardeazabal (2003) use a synthetically constructed region which has the same structural features as the Basque Country to identify the effect of conflict related deaths on the economy. After the outbreak of terrorism in the late 1960's, per capita GDP in the Basque Country declined about 10 percentage points relative to a synthetic control region without terrorism. They also find that the stock prices of firms with a significant part of their business in the Basque Country showed a positive relative performance when truce became credible, and a negative relative performance at the end of the cease-fire.

Frey, Luechinger and Stutzer (2009) study life satisfaction scores using the Eurobarometer and compare Northern Ireland with the rest of the UK and the Republic of Ireland, finding that terrorist incidents are negatively correlated with happiness. Willard, Guinnane and Rosen (1996) use an event study to look at the impact of victories on the Union's Greenback's value in gold. Zussman, Zussman and Orregaard Nielsen (2008) look for a structural break in stock price returns in Israel and the Palestinian territories around key events affecting the Israeli-Palestinian conflict. They find a significant effect on asset prices. Similarly, Zussman and Zussman (2006) find an impact of Israeli assassinations of leaders on stock markets. In an ingenious contribution Guidolin and La Ferrara (2007) look at the effect of war on the stock market value of firms using data from diamond mining firms in Angola. They use an event study methodology around the 2002 death of the rebel movement leader to identify the effect of conflict end. Collins and Margo (2007) study the impact of riots on property prices in a cross-section of 104 US cities in the 1960s

and 70s. They argue that if a riot causes a sustained decline in perceived amenities then this should show up in the relative decline of property values in the affected city. In order to tackle the endogeneity and unobserved heterogeneity problems they instrument for riots with rainfall. Abadie and Demisi (2008) show that, following the 9/11 attacks, vacancy rates experienced a much more pronounced increase in the three most distinctive Chicago landmark buildings (the Sears Tower, the Aon Center and the Hancock Center) and their vicinities than in other areas of the city of Chicago. Coyne, Dempster and Isaacs (2010) worry about persistence of conflict and look for a structural break in the time series on violence.

Even though the Northern Ireland conflict is not always classified as a civil war on standard definitions, this paper is also a contribution to the burgeoning economics literature on the causes and consequences of conflict – see Elbadawi and Sambanis (2002) for a review. Most of that literature is focused on the causes rather than the consequences of violent conflict. However, one important issue is how far the cessation of conflict does lead to economic gains which have a self-reinforcing impact on peace. To the extent that capital losses on assets follow the onset of war, we should expect the mechanism that we study here to have an impact on the sustainability of peace in the long run. Given that housing is a major asset that is fixed in place, it is a good place to start in exploring the possibility of a peace dividend.

We use Markov chain dynamics in this paper. This is also the strategy employed by Blomberg and Hess (2002) which analyzes the connection between economic well-being and conflicts. Like us, their analysis makes extensive use of persistence estimates of conflict, peace, recession and boom. However, their data does not allow these states to be defined endogenously as we do here. We show here that the measurement of regional heterogeneity is likely to be affected by the way conflict is defined.

III. Data and benchmark results

The data that we use comprise quarterly observations on eleven regions of Northern Ireland since October 1984.[5] Our house price index comes from a survey of more than one thousand open market housing transactions each quarter. The index is an attempt to get at the average house price in a region. It is not surprising in the broader economic context of this period, which includes a housing boom in the U.K. and the Republic of Ireland, that house prices have been increasing. Average nominal house price growth was 9 percent per year with significantly higher growth between 1993 and 2007.

We measure violence by the number of killings in a region – it is the clearest and most ob-

[5] While we have data on killings before 1984, there is no disaggregated house price data available.

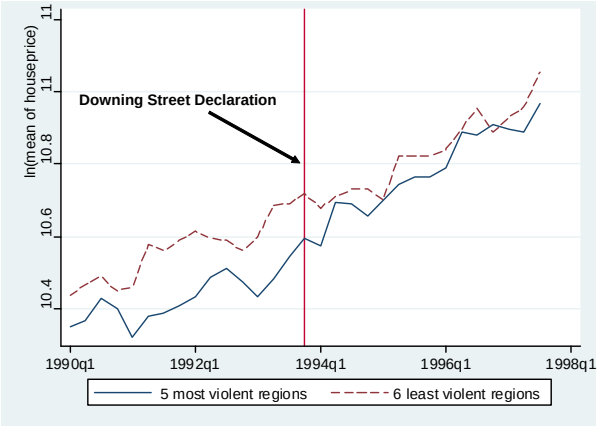


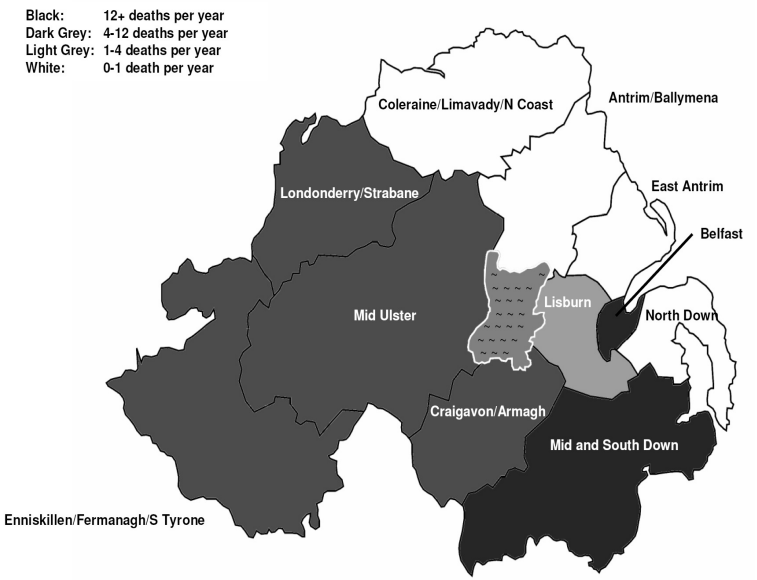
Figure 3: Average Houseprices Movements Beginning of Peace Process

jectively measurable indicator of conflict-related violence. We use the Conflict Archive on the Internet (CAIN) website which records the details of every death arising from the present conflict in Ireland, from newspaper cuttings, funerals, court records, cemeteries and books and pamphlets. The record gives the date of death 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 locate the killing in one of the 11 regions for which we have house price data thus generating the number of killings per quarter in each region. The killings data that we use include all deaths in Northern Ireland that are regarded as conflict-related by the CAIN website.

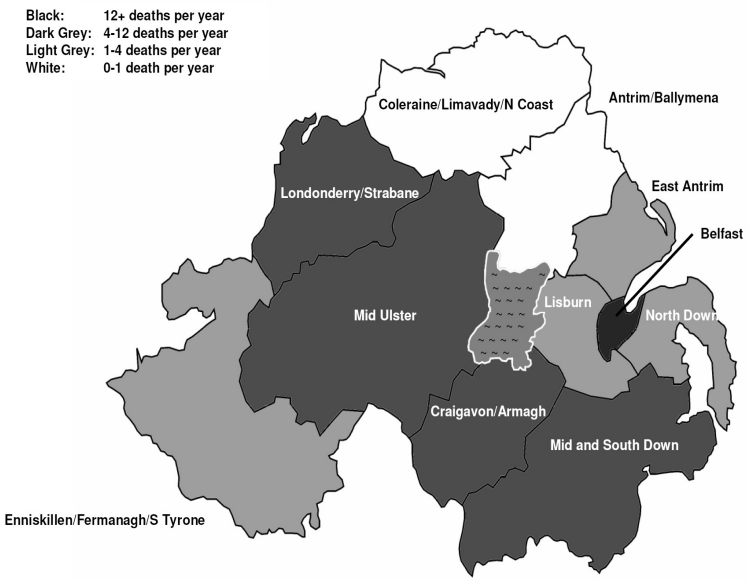
The maps in Figure 2 give a sense of how violence varied across time in the regions that we study; darker shading refers to more intense violence. It is clear from this that there is a large amount of heterogeneity in the incidence of violence across Northern Ireland. In particular, the maps show that while violence dropped radically in some regions others are constantly peaceful on the measure that we use. An initial insight into how the peace process affected house prices in violent and less violent regions differentially can be gained from Figure 3 which displays the natural log of the average house price in the 5 most violent and 6 least violent regions in the 1990s. While average house prices were significantly lower in violent regions in the years before the peace process began in 1993 they converge noticeably after the Downing Street Declaration.[6]

[6]We restrict the time window for expositional purposes. The same pattern appears when plotting the prices for whole time series 1984-2009.

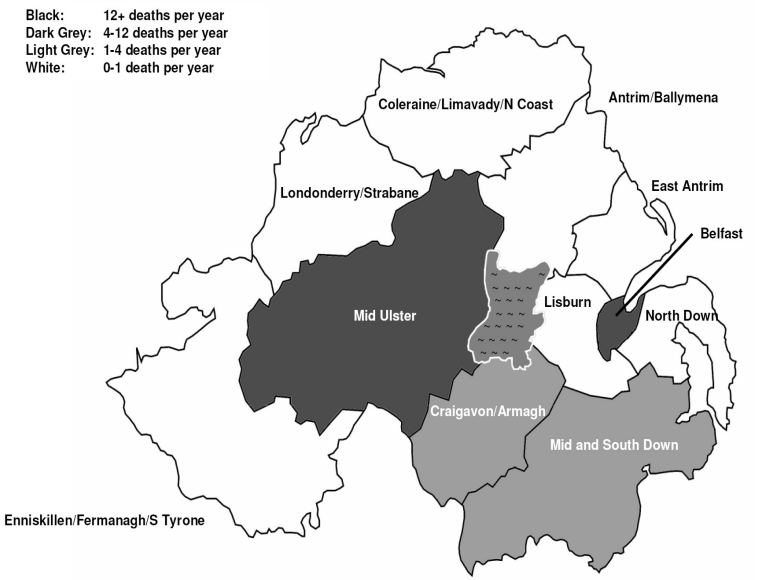
5 Year Average of Killings in Northern Ireland (1985q1-1989q4)



5 Year Average of Killings in Northern Ireland (1990q1-1994q4)



5 Year Average of Killings in Northern Ireland (1995q1-1999q4)



5 Year Average of Killings in Northern Ireland (2000q1-2004q4)

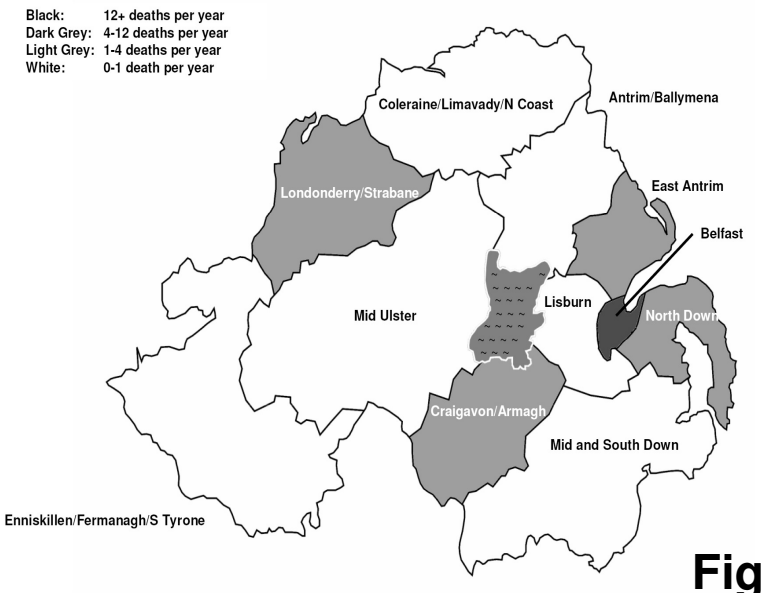


Figure 2

As a benchmark for what follows, we estimate the relationship between house prices and killings using the following semi-log model:

$$\ln(H_{rt}) = \alpha_r + \alpha_t + \beta y_{rt-1} + \varepsilon_{rt} \tag{1}$$

where $ln\,(H_{rt})$ is the natural log of our house price index for region r at date t, y_{rt-1} is the number of killings in region r lagged one quarter, i.e. at date $t-1$, α_r are region dummies, α_t are quarterly time dummies.[7] We estimate (1) with the errors ε_{rt} clustered by region. We interpret β (which we expect to be negative) as an average treatment effect of a "killing" on the house price index. The key "identifying" assumption is that there is no feedback from economic factors onto the pattern of violence conditional on (α_r, α_t).

An improvement in economic conditions following on from the peace process could also be the conduit for the effect of violence on house prices. To some extent, we will be able to see whether or not this is the case by including the unemployment rate, which fell sharply over this period, as a time varying regressor. We will also include region-specific time trends for similar reasons.

The results are in Table 1. Throughout the article we normalize our violence variables by their standard deviation to ensure comparability across columns. Column (1) gives the raw correlation between quarterly killings and house prices in the following quarter excluding any region or time effects. This correlation is negative and significant. Column (2) includes region effects and the correlation remains negative, although increases in size. Quarterly dummies are added in column (3). As expected from the common trends in regional housing prices, taking out macro-effects in this way leads to a much smaller, although still negative and significant, correlation. Column (4) shows that this correlation is robust to the introduction of region-specific time trends. Column (5) lags killings by half a year and the negative correlation result holds up (becoming a little larger in size). The estimate is robust to controlling for unemployment which takes on the expected sign. The sample here is smaller due to unemployment date only being available for a more limited time period. As a reality check, we put together a series on yearly earnings data in the tourist industry by region. Column (7) confirms the general pattern that we found with house prices.[8]

While these results are interesting, they are somewhat difficult to interpret in economic terms. Killings are being used to proxy here for the dis-amenity of living in an area of Northern Ireland

[7] We use the three-month lag of killing as house sales tend to take a while to go through. Hence, our index of house prices probably reflects sales that were agreed some time previously. All of our results hold if we include the contemporaneous level of killing instead.

[8] The coefficient indicates that one death is correlated with a loss of 1.5 million pounds of yearly tourism income. This is 6 percent of the average yearly tourism income.

Table 1: Benchmark Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
COEFFICIENT	ln(house price)	ln(house price)	ln(house price)	ln(house price)	ln(house price)	ln(house price)	pounds (millions) earned in tourist industry
killings	-0.177***	-0.212***	-0.0133***	-0.00771**		-0.0107*	-1.584***
	(0.0191)	(0.0454)	(0.00492)	(0.00295)		(0.00493)	(0.433)
killings (lagged two quarters)					-0.0187***		
					(0.00361)		
ln(unemployment)						-0.141***	
						(0.0408)	
Observations	1049	1049	1049	1049	1049	932	99
Region Fixed Effects	no	yes	yes	yes	yes	yes	yes
Time Fixed Effects	no	no	yes	yes	yes	yes	yes
Region-Specific Time Trends	no	no	no	yes	no	no	no
R-squared	0.076	0.089	0.987	0.989	0.988	0.986	0.416

Notes: The time periods are 1984q4 to 2009q1 for columns (1) through (5); 1987q3 to 2001q1 in column (6) and 1993 to 2001 in column (7). OLS standard errors are reported in columns (1) and (7), standard errors are clustered at the region level in columns (2) through (6) (* significant at 10%; ** significant at 5%; *** significant at 1%). All explanatory variables are lagged by one quarter. Deaths in columns (1) through (6) are normalized by their standard deviation. In column (7), the left hand side variable is a three year moving average from 1993 to 2001. Deaths are yearly averages lagged by four years.

Sources: Killings are conflict-related killings from Sutton (1994). Unemployment is measured using the claimant counts from the UK office for National Statistics. The house price is the average overall housing transaction price recorded by the University of Ulster. Earnings in the tourist industry is from the Northern Ireland Tourist Board.

that is in conflict. We would expect potential residents to care about the expected value of the future utility flows from this dis-amenity. However, unlike most standard (dis-)amenities like crime, disease, or good schools, whether a region of Northern Ireland is at peace or not (arguably the thing that residents should care about when buying a house) is not directly observed. We have only a rough sense that peace came to Northern Ireland some time after 1994, and the probability that a particular region of Northern Ireland is in a state of conflict is unknown. Moreover, it is unlikely to be a simple function of whether a killing took place in the current quarter, or even a linear function of the number of killings. To make progress on this, we develop a statistical model of the peace process and the way that killings changed the probability of sustained peace.

IV. A Model of House Prices and Violence

In this section, we develop a theoretical model linking house prices and violence. We then posit a stochastic model for the peace process. We discuss how the parameters of this model can be estimated using methods that have been developed to model business cycle dynamics.

A. House Prices

We assume a standard dividend-discount model of house prices where houses are infinitely lived and potential home owners have rational expectations. Assume also that the consumption value of the house (the dividend) in region r at date t can be decomposed into a "standard" part

based on amenities such as location and a part which depends on the level of violence. We write this as:

$$u_{rt} = h_r + \alpha y_{rt} \tag{2}$$

where h_r is the standard consumption value of housing based on fixed locational factors, y_{rt} is violence in period t and $-\alpha > 0$ is the peace dividend that represents how the absence of violence is being valued by residents. We treat the component h_r as fixed by region for simplicity of exposition. In the empirical analysis we allow there to be a common time effect and a region-specific time trend.

We interpret α, in line with the literature on amenities and house prices, as representing the local public bad associated with killings in a neighborhood. In our context, this is more plausible than thinking about the personal risk of being a victim. In part, therefore, α should pick up the general change in the environment and defensive measures taken to protect citizens which lowered the quality of life for residents during the Troubles.

The present value of the dividend stream determines house prices. It is now given by:

$$E\left[\sum_{i=0}^{\infty}\left(\beta^i u_{rt+i}\right) \mid \psi_{rt}, \theta_r\right] = \frac{h_r}{1-\beta} + \alpha E\left[\sum_{i=0}^{\infty}\left(\beta^i y_{rt+i}\right) \mid \psi_{rt}, \theta_r\right] \tag{3}$$

where ψ_{rt} denotes the history of violence in region r up to time t, θ_r are the parameters of the process generating violence in region r and β denotes the discount rate which is assumed to be common across time and regions.

The impact of current violence on house prices will now depend on how it changes the second term in (3). If more killings lead potential home owners to update their view of future violence, then we expect a negative relationship between (3) and violence in region r at date t. But this depends critically on the properties of the assumed process for y_{rt} which is affected by the peace process – an unobserved state which homeowners are estimating.

B. The Peace Process

We model the peace process as an independent Markov chain. Let $s_{rt} \in \{pce, con\}$ be a state variable for region r at date t where pce denotes peace and con denotes conflict. We do not observe the state directly – we can only measure the amount of violence y_{rt}. We posit that they are linked through the following "switching" model:

$$y_{rt} = \mu_{rpce}\left(1 - \delta\left(s_{rt}\right)\right) + \mu_{rcon}\delta\left(s_{rt}\right) + \varepsilon_{rt} \text{ with } \varepsilon_{rt} \sim N(0, \sigma^2_{rs_{rt}}) \tag{4}$$

where $\delta\left(pce\right) = 0$ and $\delta\left(con\right) = 1$. Thus, μ_{rpce} is the mean number of killings in the peaceful state and μ_{rcon} is the number of killings in conflict. This allows for the possibility that $\mu_{rpce} > 0$.[9] This approach is broadly consistent with the standard approach taken in the literature on civil wars where there is a threshold level of killings which needs to be passed before a region or country is deemed to be in a state of civil war.[10]

We allow the mean (and variance) of violence in each region to be a function of the state, s_{rt}. The transition matrix between states is given by:

	$s_{rt-1} = con$	$s_{rt-1} = pce$
$s_{rt} = con$	p_r	$1 - q_r$
$s_{rt} = pce$	$1 - p_r$	q_r

Linking this to (3), let $\theta_r \equiv \left\{\mu_{rcon}, \mu_{rpce,}\sigma^2_{rcon}, \sigma^2_{rpce}, p_r, q_r\right\}$ be the parameters of the peace process.

The forecast for the next period is dependent on the belief on the state s_{rt} now which is based on θ_r and the history of violence denoted ψ_{rt}, available up to period t, which includes all past killings in the region. This gives us the following expression for the second term in (3), the present value of killings:[11]

$$\begin{aligned} & E\left[\sum_{i=0}^{\infty}\left(\beta^i y_{rt+i}\right) \mid \psi_{rt}, \theta_r\right] \\ = \; & \frac{\mu_{rcon}\pi_r + \mu_{rpce}\left(1 - \pi_r\right)}{1 - \beta} + \left(\mu_{rcon} - \mu_{rpce}\right)\frac{P\left(s_{rt} = con \mid \psi_{rt}, \theta_r\right) - \pi_r}{1 - \lambda_r\beta}. \end{aligned} \tag{5}$$

where

$$\pi_r \equiv \frac{1 - q_r}{2 - p_r - q_r}, \lambda_r = q_r + p_r - 1$$

and

$$P\left(s_{rt} = con \mid \psi_{rt}, \theta_r\right) = 1 - P\left(s_{rt} = pce \mid \psi_{rt}, \theta_r\right)$$

[9] In other words, a low level of sectarian violence in some parts of Northern Ireland can be consistent with "peace".

[10] This is true, for example, in the widely used Armed Conflict Dataset (ACD); see http://www.iiss.org/publications/armed-conflict-database/

[11] See our discussion paper for details.

is the probability of conflict at each date.

This has an intuitive interpretation. The first expression is the mean discounted present value of "permanent" violence which is most easily seen when either peace is an absorbing state ($\pi_r = 0$) or conflict is an absorbing state ($\pi_r = 1$).

The second expression varies over time in response to how information derived from the history of violence over the relevant time period is updated. The term shows that the impact of $P\left(s_{rt} = con \mid \psi_{rt}, \theta_r\right)$ on expected violence is affected by the general persistence of the violence process, λ_r. More specifically, a λ_r close to one means that both peace and conflict are highly persistent and a switch from peace to conflict has a large impact on the present value of violence.

The next step is to estimate θ_r. This can be used to construct an estimate of (5). We will call this estimate $\widehat{PDV}_{rt}$ and we will use it as a regressor to explain house prices in line with equation (3) with the term $h_r/(1-\beta)$ being absorbed in the region fixed effect.

C. *Implementation*

We estimate θ_r and $P\left(s_{rt} = con \mid \psi_{rt}, \theta_r\right)$ from the data on violence y_{rt} using a well-known filter suggested by Hamilton (1989) for estimating the dynamics of business cycle states. Details of the implementation using the EM Algorithm, which is largely standard, are available in our discussion paper.

Table 2 presents the results of running the EM Algorithm for each of the 11 regions separately. The four columns report our estimates of μ_{rcon}, μ_{rpce}, p_r and q_r. These tell us about the levels of violence in the two states and the persistence. Quite clearly, Belfast is the most violent region with almost eight killings per quarter in conflict and over one in peacetime. Other regions such as Londonderry/Strabane or Mid/South Down are less violent on average but also display long persistence in their conflict (high values of p_r). As noted earlier, this persistence is an important feature of a conflict because it increases the effect that current violence can have on expectations about violence in future.

This point becomes clear by comparing two regions in our data: Londonderry/Strabane and East Antrim. East Antrim features similar estimates of μ_{rcon} and μ_{rpce} to Londonderry/Strabane but we estimate that p_r is fairly close to zero. That implies that outbreaks of violence will have relatively little impact on expectations of future violence in East Antrim since conflict is not persistent.[12]

[12]The fact that $\lambda_r < 0$ in this case does not affect the result. In fact, our regression results remain unchanged if the three violence time series for which this is the case were replaced with zeros.

Table 2: EM Estimation of Region-Specific Markov Chain Parameters

	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	8.114	1.334	0.935	0.956
North Down	1.114	0.000	0.268	0.877
Lisburn	1.333	0.000	0.288	0.799
East Antrim	1.431	0.000	0.074	0.851
Londonderry/Strabane	1.811	0.111	0.962	0.965
Antrim/Ballymena	0.986	0.000	0.000	0.894
Coleraine/Limavady N Coast	1.648	0.000	0.000	0.926
Enniskillen/Fermanagh/ S Tyrone	1.686	0.000	0.765	0.880
Mid Ulster	3.661	0.000	0.746	0.857
Mid and South Down	2.388	0.093	0.967	0.969
Craigavon/Armagh	3.273	0.266	0.643	0.844

Estimates obtained through application of the EM Algorithm discussed in Hamilton (1990) for each region seperately.

Having obtained $\hat{\theta}_r$, an estimate of the peace process parameters, we combine this with the history of violence, y_{rt}, to create a region-specific time series for the probability of conflict: $P\left(s_{rt} = con \mid \psi_{rt}, \hat{\theta}_r\right)$.[13] To illustrate this graphically, we take the mean estimates from table 2 to construct:

$$\hat{y}_{rt} = \hat{\mu}_{rpce} + \left(\hat{\mu}_{rcon} - \hat{\mu}_{rpce}\right) P\left(s_{rt} = con \mid \psi_{rt}, \hat{\theta}_r\right). \tag{6}$$

Figure 4 illustrates this for three of our regions: Belfast, Londonderry/Strabane and Lisburn. One immediate observation is that only a relatively narrow band of movements in violence triggers a change in $P\left(s_{rt} = con \mid \psi_{rt}, \hat{\theta}_r\right)$ and, hence, in the fitted value $\hat{y}_{rt}$. This is because the estimated likelihood of conflict is mostly either close to one or zero. Nonetheless, we regard this as a reasonable way of weighting the data since a change between ten and twenty killings, for example, carries less information about whether, say, Belfast is in conflict than a change from zero to ten killings.

Our estimate of the present value of violence as in equation (3) can be obtained by combining the fitted values $\hat{y}_{rt}$ with our persistence estimates $\hat{p}_r$ and $\hat{q}_r$. In fact, the only time-varying element in equation (5) is

$$\left(\hat{\mu}_{r1} - \hat{\mu}_{r0}\right) \frac{P\left(s_{rt} = con \mid \psi_{rt}, \hat{\theta}_r\right)}{1 - \hat{\lambda}_r \beta} = \frac{\hat{y}_{rt} - \hat{\mu}_{rpce}}{1 - \hat{\lambda}_r \beta} \tag{7}$$

where $\hat{\lambda}_r = \hat{q}_r + \hat{p}_r - 1$ is an estimate of the overall persistence of the Markov Chain. Thus,

[13] The starting vector is $\theta = \{3, 0, 0.5, 0.5, 3, 1\}$. Convergence is very fast (around 25 iterations) and we experimented with starting values to check that the results are robust.

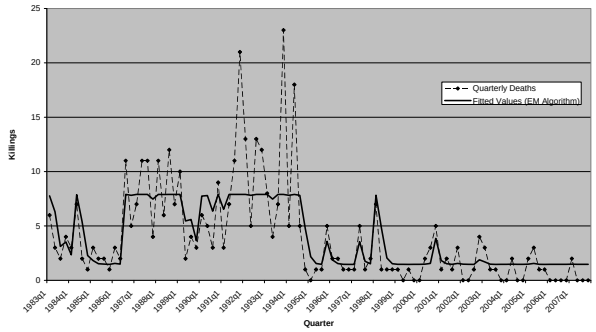


Figure 4a: Belfast Quarterly Killings and Fitted Values

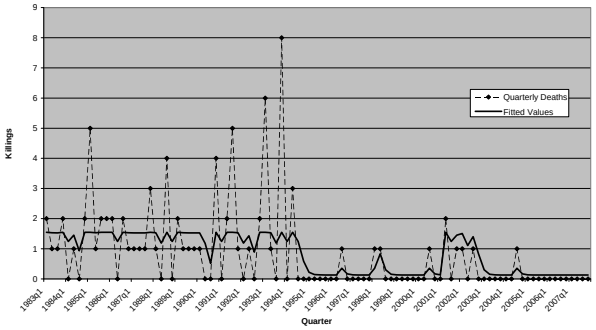


Figure 4b: Londonderry/Strabane Quarterly Killings and Fitted Values

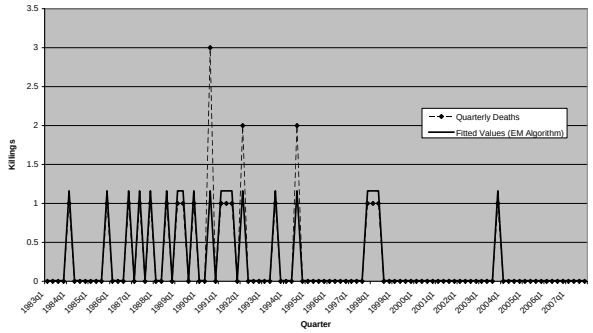


Figure 4c: Lisburn Quarterly Killings and Fitted Values

the present value of violence moves with the estimated level of killings $\hat{y}_{rt}$, and is increasing in the persistence parameter $\hat{\lambda}_r$. The impact of an additional killing will therefore be highest if it triggers a change of the conflict probability in a region with a highly persistent violence process.

The importance of factoring in persistence is illustrated by comparing the graphs of the violent regions Belfast and Londonderry/Strabane with the graph for Lisburn (Figure 4). While Lisburn had some violent incidents, the violence there rarely persisted for more than one quarter. In line with this observation, Table 2 confirms that our estimate of p_r is 0.288 for Lisburn which is low compared to the corresponding estimate of over 0.9 for Belfast and Londonderry/Strabane. Thus, we would expect a change from peace to conflict to have somewhat different implications for expectations and, hence, house prices in the three regions. If we were only to use $\hat{y}_{rt}$ directly to explain house prices, this would be ignored.

V. Results

This section presents the core results as well as a number of variants and robustness checks.

A. Core Results

The core results are presented in Table 3. They are estimates from running regressions of the form:

$$\ln(H_{rt}) = \alpha_r + \alpha_t + \beta \widehat{PDV}_{rt-1} + \varepsilon_{rt} \tag{8}$$

where, as above, α_r are region dummies, α_t are quarterly time dummies. The variable $\widehat{PDV}_{rt-1}$ is our computed measure of the expected discounted number of future killings from (3) as computed in the previous section. The results are reported with standard errors clustered by region.[14] We will assess the robustness of the approach to timing and the assumed discount factor. As our baseline case we choose a 5 percent discount rate.

Column (1) of Table 3 shows that there is a significant negative correlation between our (lagged) measure of the discounted value of violence and house prices. Below, we will discuss the size of this effect in economic terms. Column (2) shows that this correlation remains when the present value is calculated with a discount rate of 1 percent. Although the size of the coefficient

[14] We have also estimated the standard errors using a bootstrap method given that the distribution of $\widehat{PDV}_{rt-1}$ is not known and there is the possibility of generated regressor bias. Details of this method and results are available from the authors. In essence, it involved drawing 1000 replications from the violence data for each region and computing the EM estimate $\hat{\theta}_r$ for each replication. The $\hat{\theta}_r$ estimates were used to generate an empirical frequency distribution of $\widehat{PDV}_{rt-1}$ to calculate standard errors. Results are displayed in the web appendix.

Table 3: Main Results

COEFFICIENT	(1) ln(house price)	(2) ln(house price)	(3) ln(house price)	(4) ln(house price)	(5) ln(house price)	(6) ln(house price)	(7) ln(house price)
present value of killings (r = 5%)	-0.0604***			-0.0575***	-0.0601***	-0.0415**	-0.156***
	(0.0147)			(0.0154)	(0.0142)	(0.0173)	(0.0511)
present value of killings (r = 1%)		-0.209***					
		(0.0496)					
present value of killings (r = 5%), lagged			-0.0595***				
			(0.0129)				
ln (unemployment)				-0.141***			
				(0.0414)			
housing starts					0.0188***		
					(0.00860)		
Observations	1049	1049	1049	932	924	1049	1441
Regions	11	11	11	11	11	11	15
Region Fixed Effects	yes	yes	yes	yes	yes	yes	yes
Time Fixed Effects	yes	yes	yes	yes	yes	yes	yes
Region Specific Time Trends	no	no	no	no	no	yes	yes
R-squared	0.988	0.988	0.988	0.987	0.986	0.989	0.962

Notes: The time periods are 1984q4 to 2009q1 for columns (1-3, 6-7); 1987q3 - 2009q1 for column (4) and 1988q2 - 2009q1 in column (5). Standard errors are clustered at the region level (* significant at 10%; ** significant at 5%; *** significant at 1%). All explanatory variables are lagged by one quarter. Present values and private starts are normalized by their standard deviation. Column (7) adds quarterly UK houseprice series from the Nationwide Building Society: North West, Yorkshire, East Midlands and Wales.

Sources: Present value of killings are calculated (see equation 5 in the text) from the conflict-related killings and the EM estimates in table 2. Unemployment is measured using the claimant counts from the UK office for National Statistics. The house price is the average overall housing transaction price recorded by the University of Ulster: Housing starts are private housing starts from the District Council Building Control Offices.

changes quite dramatically, as we will discuss below, it is similar in magnitude from an economic point of view.

In column (3), we test robustness of our core result to lagging our present discounted value measure by half a year. The result is robust. Columns (4) and (5) respectively introduce the unemployment rate and private housing starts as additional regressors. The latter is included to try to control for any changes in housing supply. The coefficient on the present discounted value measure of killings is identical. Finally, column (6) introduces region-specific time trends. Although the size of the coefficient is a little smaller, the core correlation that we would expect if there is a genuine peace dividend is present in the data.[15]

Given the availability of regional data our focus here is on within-Northern Ireland comparisons. We argue that identifying the costs of the conflict from within variation is relatively clean as factors that affected all regions in the same way are automatically held constant. However, this might lead to an underestimate of the true cost of conflict as a lot of the time variation related to conflict is captured by the time fixed-effects. In column (7) of Table 3, we add four other regions from the UK (North West England, Yorkshire, East Midlands and Wales) as an additional control group, with the present value of killings being set to zero for these regions over the whole period that we study.[16] The coefficient on the present value of violence triples in size in this specification

[15] We also introduced squared and cubic time trends with identical results.

[16] These data on house prices come from the Nationwide Building Society. The choice of these regions was based on the level of house prices being similar to Northern Ireland in 2009 q4. The results do not change substantively if we use

suggesting that our within-Northern-Ireland estimates of the peace dividend are in all likelihood a lower bound.

Taken together, these results provide convincing evidence of a Northern Ireland peace dividend.

B. *Extended Results*

In this section we investigate some alternative specifications and assess the robustness of the findings.[17] These extended results appear in Table 4.

We have supposed that it is aggregate killing within a region which reflects the amenity cost of living in a neighborhood. However, another interpretation of the results is that it is the probability of the unobserved latent state – peace or conflict – that really matters to residents. After all, there are many aspects of violence beyond killings that made life during the Troubles unpleasant and these are likely to be correlated with killings. Suppose instead, therefore, that house prices are not affected by killings but by the underlying state s_{rt}. Hence the utility flow from a house is now:

$$u_{rt} = h_r + \alpha' \delta(s_{rt}). \tag{9}$$

In this case, the peace dividend is α' and is the amenity being valued is peace itself. This slightly modified utility function gives rise to the following present discounted value of housing in region r at date t:

$$E\left[\sum_{i=0}^{\infty}\left(\beta^i P\left(s_{rt} = con \mid \psi_{rt}, \theta_r\right)\right)\right] = \frac{1 - q_r + h_r}{1-\beta} + \frac{P\left(s_{rt} = con \mid \psi_{rt}, \theta_r\right)}{1 - \lambda_r \beta}. \tag{10}$$

Our method is easily adapted to assess the robustness of our findings to this alternative view as we already have an estimate of λ_r and $P\left(s_{rt} = con \mid \psi_{rt}, \theta_r\right)$. Following this, column (1) of Table 4 includes the estimated value of

$$\frac{P\left(s_{rt} = con \mid \psi_{rt}, \theta_r\right)}{1 - \lambda_r \beta}$$

a larger set of comparators: North, North West, Yorkshire, East Midlands, Wales and Scotland.

[17] There are two other robustness checks not reported in Table 4. First, we used a Poisson model instead of a Normal distribution in fitting the Markov switching model. The EM algorithm had problems converging in the very low violence regions so we set the level of violence to zero and used the estimates only for regions with significant amounts of violence. The findings are very similar to those in Table 3 and are presented in the web appendix. Second, we estimated the Markov model on all of the violence data (before the period where our house price data begins). Again the results in Table 3 were also robust to doing this.

as regressor in place of $\widehat{PDV}_{rt}$.

A similar qualitative story emerges to what we found in Table 3. In particular, the results remain robust to including region-specific time trends. The magnitude of the effect, however, is relatively low. This is perhaps not too surprising given that $\widehat{PDV}_{rt}$ can be thought of as an interaction term between the probability of conflict and the region-specific difference between killings in peace and violence: $\left(\mu_{rcon} - \mu_{rpce}\right)$. Hence, by focusing only on the conflict probability in the specification in column (1) of Table 4, we are neglecting the additional regional heterogeneity reflecting the intensity of violence.

Our independent Markov chain model is flexible in that it allows each region of Northern Ireland to be in a state of peace or conflict independently. Hence, home owners are deemed to make a local assessment of the peace process and what it means for them in the region. However, another plausible view is that the core assessment on peace is a macro-economic effect based on all violence in Northern Ireland.[18] On this view, we should model the probability of peace as a single index.

We implement this idea as follows. First, we add all the regional quarterly killings to create an aggregate Northern Irish time series of killings. This time series is then fed into the EM Algorithm to produce an estimate of the probability of conflict for Northern Ireland as a whole which is denoted by $P(s_t = con \mid \psi_t, \theta_t)$. In a second step, we test the extent to which this overall probability of violence for Northern Ireland can explain the variation in regional violence. We do this simply by running eleven OLS regressions, one for each region, as follows:

$$y_{rt} = \gamma_r + \tau_r P(s_t = con \mid \psi_t, \theta_t) + \varepsilon_{rt}. \tag{11}$$

This provides us with an estimate of the average level of violence in peace (γ_r) and the impact of the conflict (τ_r) on the level of violence for each region. Depending on the magnitudes of regional violence and the correlation with $P(s_t = con \mid \psi_t, \theta_t)$, this gives a new estimate of the mean levels of violence during peace and conflict. (The estimated region-specific intercept is the average death-count in peacetime while the estimated constant plus slope coefficient are the average death-count in conflict.) Note, however, that not all coefficients that we estimate this way are statistically significant. Most peaceful regions, for example, have no significant slope coefficient implying no impact of the estimated Northern Irish conflict on their regional violence levels, i.e. the series $P(s_t = con \mid \psi_t, \theta_t)$ is simply not correlated with the y_{rt} for such regions. As a final step we use all slopes and constants in each region to generate a panel

[18] We are grateful to Daron Acemoglu for persuading us to look at this alternative interpretation.

Table 4: Extended Results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
COEFFICIENT	ln(house price)	ln(house price)	ln(house price)	ln(house price)	ln(house price)	ln(house price)	ln(house price)
conflict (present value at r = 5%)	-0.0209**						
	(0.00732)						
present value of killings (r = 5%) single index EM calculations		-0.0463***	-0.0363**	-0.0280**			
		(0.0142)	(0.0151)	(0.0108)			
ln (unemployment)			-0.126**				
			(0.0425)				
present value of killings per capita					-0.0436**		
					(0.0152)		
present value of killings (r = 5%)						-0.0359**	-0.0556**
						(0.0122)	(0.0196)
boundary to Belfast * PV							0.0327*
							(0.0167)
boundary to Londond./Strab. * PV							0.0266
							(0.0377)
boundary to Mid Ulster * PV							-0.00742
							(0.0368)
boundary to Mid/South Down * PV							-0.0823***
							(0.0156)
boundary to Craigavon/Armagh * PV							-0.0230
							(0.0346)
Observations	1049	1049	924	1049	1049	953	1049
Region Fixed Effects	yes	yes	yes	yes	yes	yes	yes
Time Fixed Effects	yes	yes	yes	yes	yes	yes	yes
Region-Specific Time Trend	yes	no	no	yes	no	no	no
R-squared	0.989	0.988	0.987	0.989	0.987	0.988	0.988

Notes: The time periods are 1984q4 - 2009q1 for columns (1-3, 5-7) and 1987q3 - 2009q1 for column (6). Standard errors are clustered at the region level (* significant at 10%; ** significant at 5%; *** significant at 1%). All explanatory variables are lagged by one quarter. All violence variables in columns 1-6 are normalized by their respective standard deviation. PV-interactions use present value calculated at 5 percent of respective region. Column (1) uses the present value of the conflict probability. Columns (2-4) uses the single index model (see section 6.2). Column (6) excludes Belfast.

Sources: Present value of killings (equation 5) and present values of conflict (section 6.2) are calculated from the conflict-related killings and the EM estimates in table 2. Unemployment is measured using claimant counts from the UK office for National Statistics. The house price is the average overall housing transaction price recorded by the University of Ulster. Per capita calculations use population from the 1991 census from the Census Office for Northern Ireland.

of fitted killings.[19] We then proceed as in the previous section to generate an estimate, $\widehat{PDV}_{rt}$ which we include as a regressor. Note that in this specification there is no difference between the present value and fitted killings because the persistence parameters p and q are now identical across regions, i.e. there is single estimate of λ for all of Northern Ireland.

Columns (2) to (4) in Table 4 report the regression results when this single index approach is used. The core results are robust to this method – a negative correlation between house prices and this region-specific measure of violence remains. As with the core results, this finding is robust to including unemployment and region-specific time trends as regressors (columns (3) and (4)).

Our analysis implicitly assumes that violence is a local public bad whose impact on welfare is independent of population size. However, one possibility is that people care less about violence when their personal probability of being affected by violence is lower. This would be captured by looking at per capita rather than aggregate deaths within a region. To explore this, we use the present value per capita as a regressor in column (5) of Table 4. Our core result is robust to this. Also, it should be noted that if we use both the per capita and the non-weighted present value in the same regression only our original present value measure is statistically significant.[20] Thus our results do not appear to be driven in any way by population numbers in more violent areas.

[19] Our results are robust to using only the significant coefficients for generating the $\hat{y}_{rt}$.

[20] We also checked whether the level of pre-sample violence in each region or measures of Protestant-Catholic polarization affect the relative impact of violence on the houseprice. In each case the interaction with our $\widehat{PDV}_{rt}$ variable is insignificant if the original $\widehat{PDV}_{rt}$ is added.

We can also check whether the results are driven by the most violent region in the data, namely Belfast. There is a risk that this observation is the most influential for our findings. To test for this, column (6) in Table 4 reports the results excluding Belfast. The coefficient is only slightly smaller and is still strongly significant.

Our core results assume that the impact of violence is confined to the geographic area for which we measure house prices. However, it may be that home owners care about the level of violence in other regions when choosing where to live. This could either be because of a direct spillover or because home owners are choosing ex ante where to live creating general equilibrium price changes.

To consider this possibility, we look for spillover effects from the most violent regions: Belfast, Craigavon/Armagh, Londonderry/Strabane, Mid Ulster and Mid/South Down onto house prices in adjacent regions. Thus, we create a dummy variable denoting whether a region has a boundary with one of these regions and interact that with the $\widehat{PDV}_{rt}$ in the adjacent region. These interaction terms are shown in column (6) and give us an interesting finding. First, we find a core "own correlation" which is negative and significant and of similar magnitude to the core results. Among the interaction terms all results bar Belfast are suggestive of a negative spillover of violence across regions. However, only one of these coefficients is significant at a 5 percent level.[21] The correlation of house prices in adjacent neighborhoods with Belfast is positive. This is consistent with a flight away from living in Belfast to adjacent neighborhoods in response to the violence. Although we do not have evidence on migration directly, this explanation is consistent with broad changes in population captured by population statistics provided by the Northern Ireland Statistics and Research Agency (NISRA). According to their data, population in Belfast declined from 316,358 inhabitants in 1981 to 267,374 in 2006.[22] The view that this reflects at least partly local migration is supported by the fact that population increased in all other twenty-four local government districts throughout the same period.

C. Economic Significance

We now consider the size of effect that is predicted by our empirical models. For this, we take the result in column (1) in Table 3 and use it to compute the 95 percent confidence interval of the percentage change in house prices associated with a unit change in the present value of killing. The boundaries of this interval are then multiplied by the region-specific estimates of the present

[21] The Mid/South Down region had a relatively high share of killings of British Army soldiers - it is not unreasonable that the effect of these killings is less local.

[22] NISRA population data is available online under http://www.nisra.gov.uk/. The population statistics give population densities and area.

Table 5: Economic Significance of Region-Specific EM Model and Semi-Log Regression Estimates

	Present Value Estimates				Semi-Log 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) lower bound	upper bound	Mean Level of Violence in Period 1983-1994	Impact of Conflict on Houseprices in Percent (95% Confidence Intervall) lower bound	upper bound
Belfast	4.67	2.82	**5.87**	**16.58**	7.114	**2.30**	**5.74**
North Down	0.19	0.13	**0.17**	**0.48**	0.091	**0.03**	**0.07**
Lisburn	0.30	0.24	**0.19**	**0.53**	0.545	**0.18**	**0.44**
East Antrim	0.22	0.17	**0.17**	**0.49**	0.205	**0.07**	**0.17**
Londonderry/Strabane	1.13	0.53	**1.91**	**5.39**	1.909	**0.62**	**1.54**
Antrim/Ballymena	0.12	0.08	**0.12**	**0.33**	0.114	**0.04**	**0.09**
Coleraine/Limavady N Coast	0.16	0.09	**0.20**	**0.57**	0.182	**0.06**	**0.15**
Enniskillen/Fermanagh/ S Tyrone	0.62	0.44	**0.57**	**1.62**	1.318	**0.43**	**1.06**
Mid Ulster	1.38	1.04	**1.08**	**3.04**	2.341	**0.76**	**1.89**
Mid and South Down	1.51	0.63	**2.77**	**7.83**	2.455	**0.79**	**1.98**
Craigavon/Armagh	1.20	0.97	**0.73**	**2.07**	2.205	**0.71**	**1.78**
Average	1.05	0.65	**1.25**	**3.54**	1.68	**0.54**	**1.36**
Average (population weights)	1.58	0.97	**1.93**	**5.44**			

Notes: Present values are normalized by their overall standard deviation. Population weights are by 1991 population from NI census. Mean level of violence in peace is assumed to be zero for the calculation of the peace dividend with the raw violence data.

value of killings in conflict minus those in peace. The results are in Table 5 which also gives the (normalized) present value estimates.

Our Markov switching model predicts that peace leads to an increase in house prices of between 1.3 percent and 3.5 percent all else equal. However, these effects are highly heterogeneous across regions. For Belfast where violence was greatest, the estimate for a change in house prices is between 5.9 percent and 16.6 percent using a 5 percent discount rate.

It is interesting to compare these results with what would emerge from the average coefficient on killings which we estimate from the benchmark OLS model. These appear in the final three columns of Table 5. We allow this effect to be heterogeneous across regions by applying our estimates of the mean difference in violence from estimates in the Markov switching model. This model predicts a smaller effect of violence on house prices compared to the model based on a $\widehat{PDV}_{rt}$ calculation. The 95 percent confidence interval ranges from 0.5 percent to 1.4 percent. But more striking is the way that the models handle heterogeneity in the impact of violence. For Belfast, the estimate is from 2.3 percent to 5.6 percent with the upper bound lying below the lower bound of the model based on $\widehat{PDV}_{rt}$. In general all the estimates of the benchmark model in more violent regions are lower than their counterparts based on the Markov switching model.

The magnitudes found are not closely tied to the specific estimates that we use from among those presented in Tables 3 and 4. They are essentially unaffected by using the estimates for a 1% discount rate when we compute $\widehat{PDV}_{rt}$. Estimates from the single index model described in

the previous section also yield very similar results.[23] This robustness is encouraging suggesting that choosing between this model of an aggregate peace process and the region-by-region model is of no great significance to the economic findings of the paper.

VI. Relevance to Other Conflicts

The method that we are proposing for looking at conflict is potentially applicable in other contexts. Here, we illustrate from two other contemporary conflicts.

First, we ran the Markov switching model on time series data on civilian casualties in Iraq. Since Iraq is not at peace at the moment, it is a bit difficult to think in terms of peace dividend. But we are able to calibrate the economic impact of the "surge" which began in early 2007. Our model predicts a change of state in the underlying violence generating process in the Summer of 2008 - some time after the surge began. We apply our estimate of the peace dividend assuming that violence in Iraq were to drop to levels that we have calibrated in Belfast after the peace process with a similar level of persistence. However, we scale up the size of the effect to reflect the population size difference between Belfast and Iraq.[24] Our estimate of the peace dividend for Iraq after the surge is then around 30 percent.

Second, we look at the Israel/Palestine conflict where we use data provided by Jaeger and Paserman (2008) to estimate the parameters of a peace process between September 2000 and December 2005. Again, we use a single time series which picks up broad trends such as the rise of violence at the end of 2000, the brief decline at the end 2003 and the longer lasting decline of violence after February 2005.

In order to get some idea of how the economy reacts to violence we matched the raw violence data and our estimates with stock market data from the Tel Aviv stock exchange. Table 6 shows the correlation between our generated conflict probability measure and a stock market index. For comparison we also show the correlation between the raw deaths data and the stock market value. Our estimated conflict probability seems to explain a higher share of the variation (R-squared of 0.57 as opposed to 0.23). A straight OLS regression of stock market values on the probability of conflict suggests that the perception of an end to the Intifada would correspond to a stock market recovery of roughly 56 percent.[25]

[23] These are available in the on-line web Appendix.

[24] The described calculations lead to a present value of civilian deaths during peace in Iraq of 8176 and 15070 in conflict. The difference needs to be normalized to make it comparable to the Northern Ireland data (standard deviation of the present value is 23 while population is roughly 61 time higher in Iraq than in Belfast). Using the estimate from table 3 we get: $\frac{15070-8176}{61*23} * 100 * 0.0604 = 29.68$.

[25] Note, however, that this estimate could be driven by a host of omitted factors. An application of our within-Northern Ireland estimates (using similar method to that which we used for Iraq) suggests a stock market value recovery of roughly 14 percent after the end of the second Intifada.

Table 6: The Tel Aviv Stock Market and Violence

VARIABLES	(1) ln(stock market)	(2) ln(stock market)
conflict probability	-0.558***	
	(0.1069)	
deaths		-0.1255**
		(0.0479)
Constant	6.592***	6.367***
	(0.0881)	(0.0830)
Observations	21	21
R-squared	0.568	0.227

Notes: The time period is 2000q4 - 2005q4. OLS standard errors reported (* significant at 10%; ** significant at 5%; *** significant at 1%). Deaths are normalized by their standard deviation.

Sources: Stock market is the closing TA-25 index value. Deaths are total deaths from Jaeger and Paserman (2008). Conflict probability is the EM estimate of the conflict probability using deaths.

In both cases, our results are purely illustrative and there are a lot of assumptions behind them. But we hope that it shows the value of a having a structured approach to the underlying model of peace where the persistence of the underlying peace process as well as the level of killing plays a crucial role. Given that one of the most difficult assessments that citizens living in conflict areas have to make is whether peace will hold, this is surely central to assessing the economic value of reduced violence.

VII. Concluding Comments

This paper has looked at the effect of violence in Northern Ireland on house prices. The peace process of this region provides an interesting context in which to look at the peace dividend as measured by home owners' willingness to pay for houses. The novelty of our study lies partly in the data – we have both spatial (within-region) and quarterly temporal variation in violence to exploit in measuring how much changes in violence has affected house prices. Our approach also compares findings from a standard OLS estimate with one derived from an empirical model which is more grounded in economic theory and a model of the underlying peace process.

Both approaches suggest that there is a negative relationship between house prices and killings in line with what we would expect. However, the economic model yields somewhat different conclusions on the size of the peace dividend and its distribution across regions. This makes sense since we would expect the process that generates a mapping between house prices and violence to vary according to the persistence in the reduction in violence. Also interesting is the evidence on spillover across areas suggesting that some kind of general equilibrium response to violence including migration across regions may be at work.

What we have estimated here is the non-macro component of the peace dividend. To the

extent that there are common components that have lifted all regions of Northern Ireland, they are absorbed in the quarterly dummy variables. However, given other macro-effects including the rapid growth rate of the Republic of Ireland over this period, it is close to impossible to reliably estimate this effect. But it is perfectly possible that these effects are larger than those that we have estimated here. The evidence where other U.K. regions are used as a control group is suggestive of this.

Sustaining peace is always a challenge in places where there are long-lived political and social tensions. It is necessary to convince those involved in supporting and perpetrating violence that there are manifest benefits to peace. This study shows that home owners' willingness to pay to live in regions where violence decreased in Northern Ireland created a tangible stake in the maintenance of the peace process by capitalizing the future value of peace.

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