

# The Impact of Energy Performance Certificates On The Price and Rent Of Dwellings

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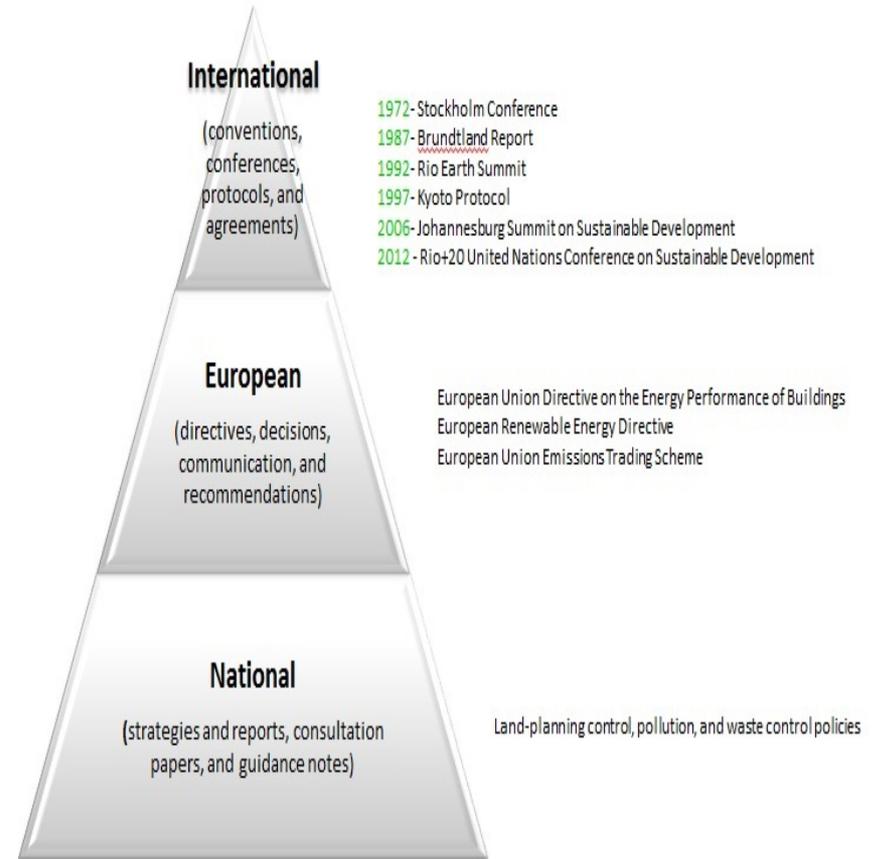
**Professor Jim Berry**  
**Professor Stanley McGreal**  
**Dr. Michael McCord**

# The Sustainability Agenda

1. 1960s and 1970s environmental issues- depletion of resources and changing climate

2. Key works:

- Silent Spring (Carson, 1962),
- The Tragedy of the Commons (Hardin, 1968),
- Limits to Growth (Meadows et al, 1972).



Source: Strong and Hemphill (2006)

# Green Buildings

## Reasons for Revolutions:

1. Global warming (Yudelson, 2008)
2. Rising energy prices (Chwieduk, 2003)
3. High levels of GHG (Stern Report, 2005; Garnaut Report, 2007)

## Green Buildings (UKGBC, 2009)

- ✓ resource-efficient
- ✓ minimises the negative building impacts
- ✓ stimulates the economy

## The Impacts:

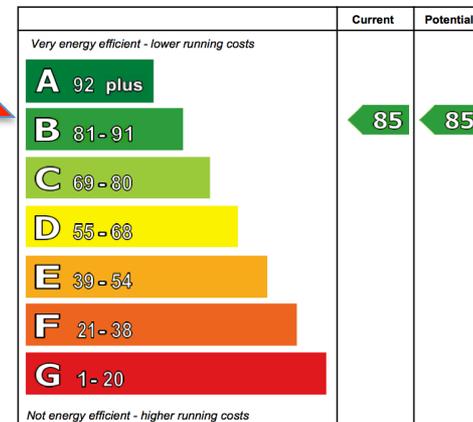
1. Specific task forces develop sustainable building policies and legislations, education and promotion, and assessment tools (Warren-Myers and Reed, 2010).

# Green Buildings (Cont...)

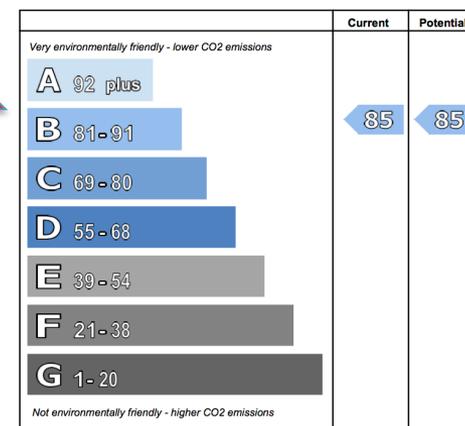
## Energy Performance Certificate (EPC)

-European Union Energy Performance of Buildings Directive requires all buildings (built, sold, rented) to have energy certificates in the form of Energy Performance Certificate (EPC).

Better energy efficiency



Better environmental performance



# Green Buildings (Cont...)



## The Impacts:

2. More research and development in the area of social behaviour (work productivity), economics (price/rent premium), and investments.

## Issues in Green Residential Economics Research

1. Limited studies/evidence

-Data unavailability (Goodwin, 2011)

2. Inconsistent findings

-**Premium** (Aroul and Hansz, 2012; Bloom et al, 2011; Brounen and Kok, 2011; Cajias and Piazzolo, 2013; Deng et al, 2012; McCord et al, forthcoming; Shimizu, 2010; Fuerst et al, 2015) or **discount** (Yoshida and Sugiura, 2011; Zheng et al, 2012)?

= confuses the property market players (Keeping and Shiers, 2004)



# Green Buildings (Cont...)

1. Global natural resource consumption:  
 45 to 50% of energy  
 50% of water  
 60% of raw materials  
 80% of agricultural land  
 60% of timber

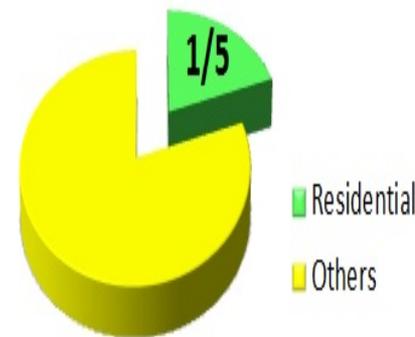
2. Pollution:  
 23% of air  
 50% of GHG  
 40% of water  
 50% of waste  
 50% of the ozone)

(Edwards, 2010)

45% Commercial  
 55% Residential

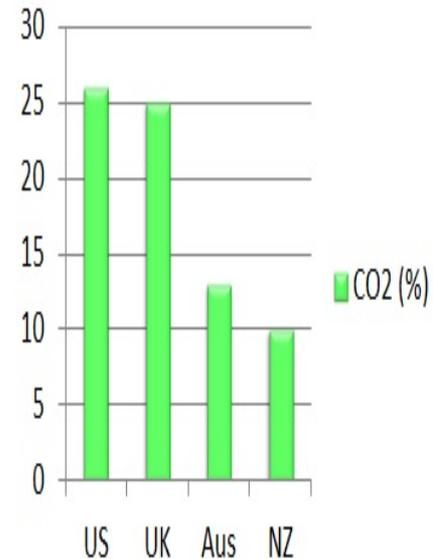
Sullivan (2007)

Figure: Total global energy consumption according to sectors



Source: Brounen et al (2012; 2013)

Figure: Total carbon (CO2) emissions from residential sector in a country

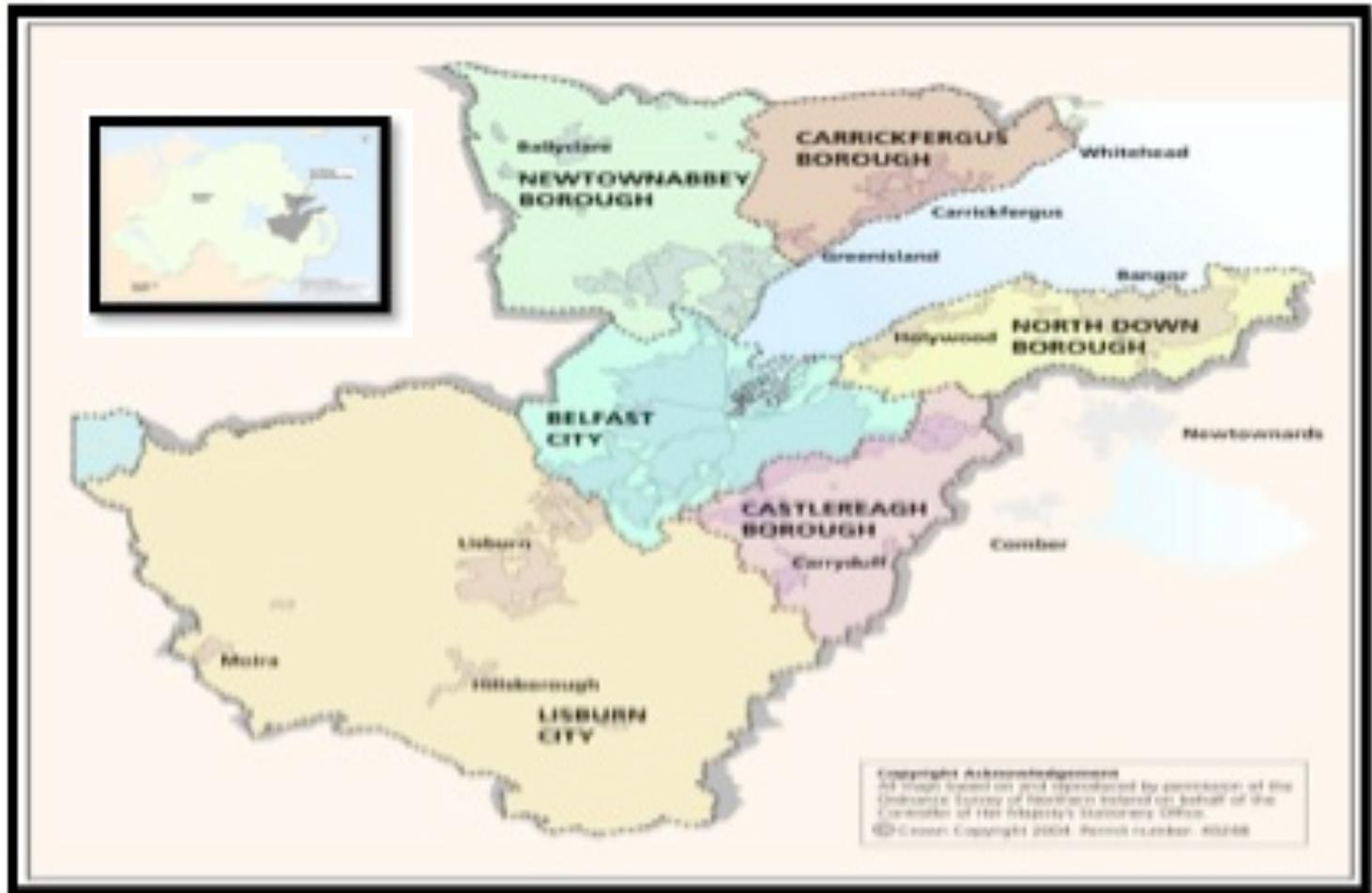


# Aim & Hypotheses



- Aim: To establish whether there is a green premium associated with dwellings within the Belfast Metropolitan Area.
- Hypotheses: There is a green premium for better energy efficiency

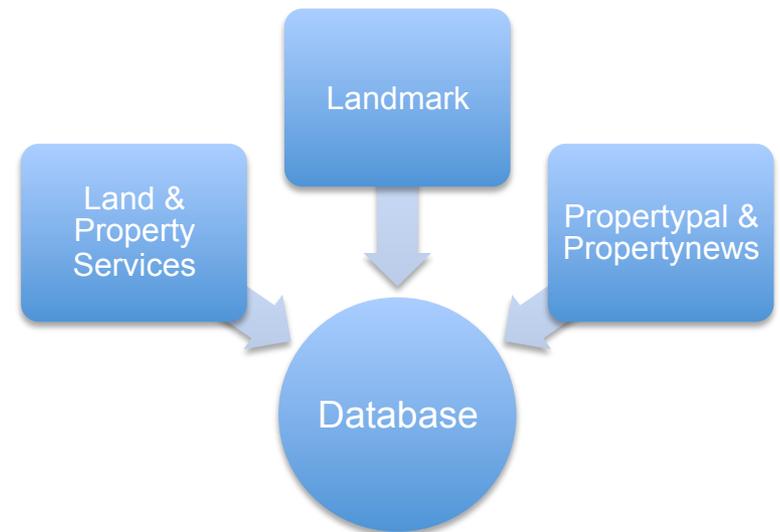
# The Study Area- Belfast Metropolitan Area



1. Belfast
2. Carrickfergus
3. Castlereagh
4. Lisburn
5. North Down
6. Newtownabbey

# Data & Sources

Data	Property news	Property pal	LPSNI	Landmark
Address	✓	✓	✓	✓
Date listed	✓	✓		
Property type	✓	✓		✓
Bedrooms	✓	✓		
Receptions	✓	✓		
Asking Price/ Asking Rent	✓	✓		
EPC rating/ EPC band	✓	✓		✓
Size			✓	
Garage			✓	
Age			✓	



# Analysis Method

Hedonic model (Lancaster, 1966; Rosen, 1974)

Assign attribute prices based on the relationship between the observed prices of differentiated products and the number of attributes associated with these products.

In the housing context, the hedonic model is adopted by regressing the sales price on various house characteristics

Typical hedonic house price function

$$P(Z) = f(S, L) + \varepsilon$$

Where:

P is a vector of observed house prices;  
S and L are vectors of structural attributes and locational attributes respectively;  
 $\varepsilon$  is a vector of random error terms.

The hedonic model is used to measure environmental externalities and its impact towards house prices:

Price increase: 10%-20% green spaces (parks and forests)- Wolf (2007)

Price decrease: 10% fire (Loomis, 2004), flood (Yeo, 2004), and noise (Theebe, 2004).

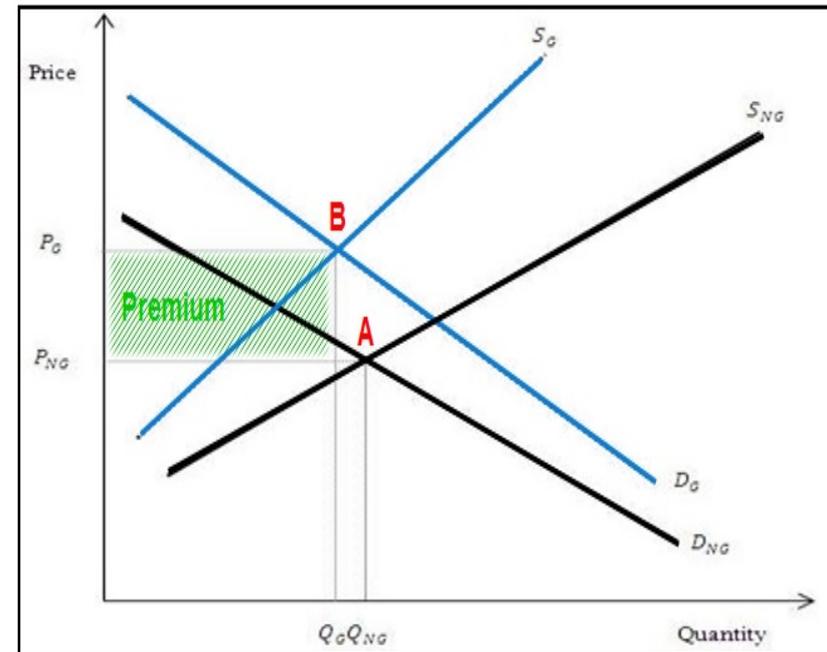


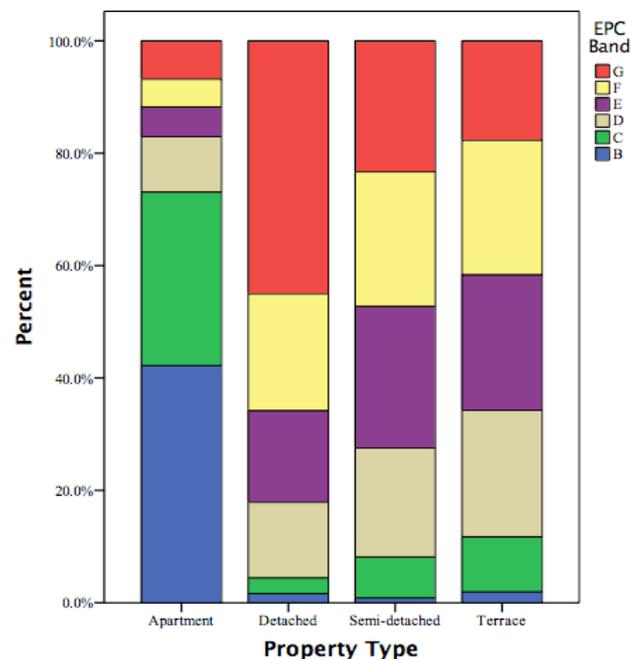
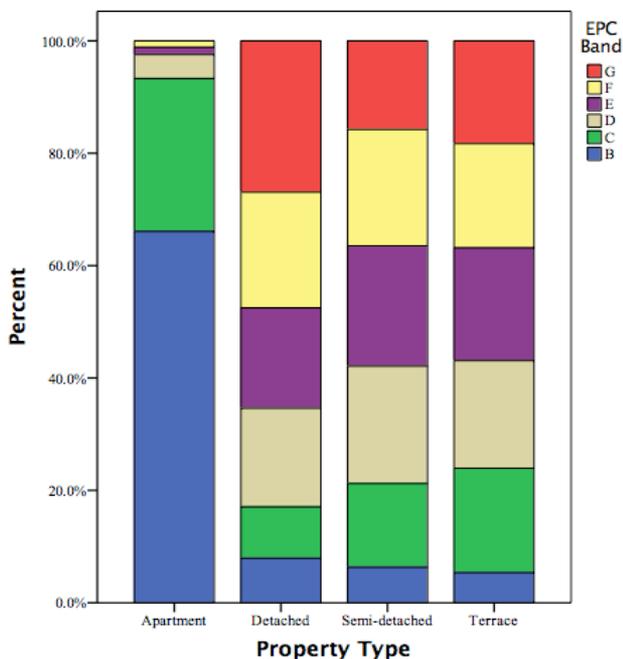
Figure: Price premium model for green buildings

Source: [Fuerst and McAllister \(2011b\)](#) and [Aroul and Hansz \(2012\)](#)

# EPC Bands and Property Type

## Asking Price Model Dataset

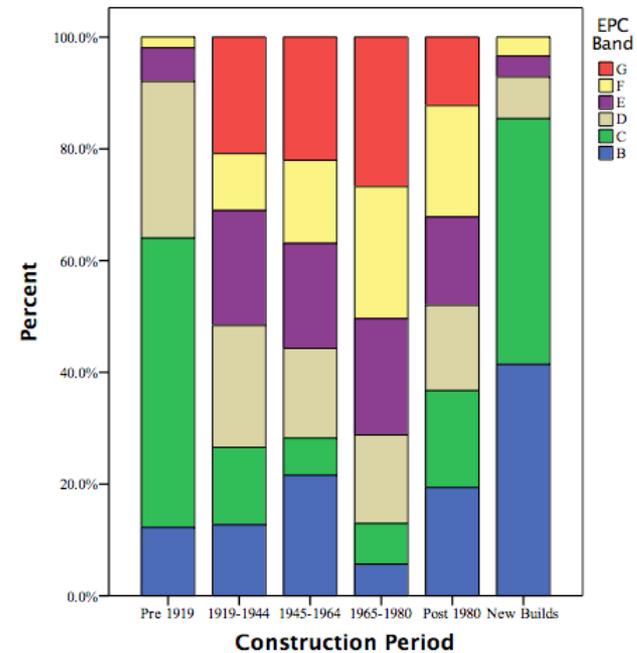
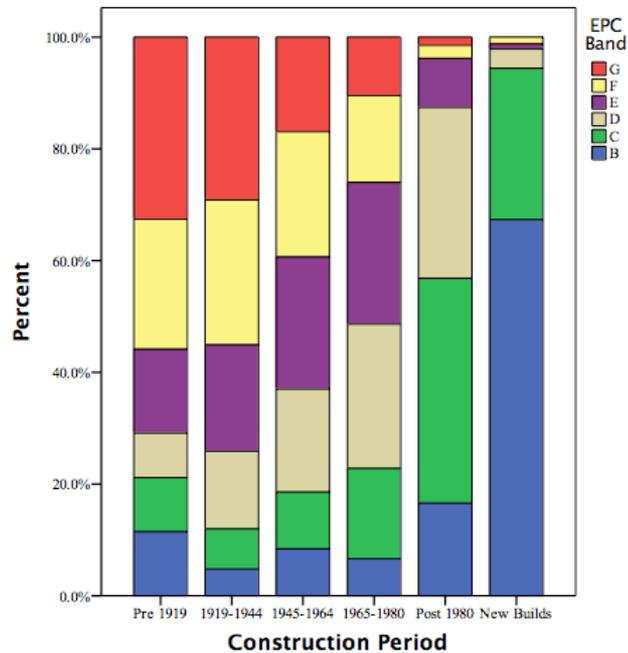
## Asking Rent Model Dataset



# EPC Bands and Construction Period

## Asking Price Model Dataset

## Asking Rent Model Dataset



Variables	Linear Model I	Linear Model II	Semi-log Model	Price (per m <sup>2</sup> ) Model	Interactive Model
	B (t)	B (t)	B (t)	B (t)	B (t)
<b>Intercept</b>	-56530.673** (-15.719)	-33720.783** (-12.537)	4.466** (383.142)	609.564** (17.891)	-32474.299** (-12.343)
<b>Price</b>					
<b>Size</b>	862.987** (44.102)	862.178** (44.006)	0.002** (29.673)		888.794** (44.726)
<b>Bedrooms</b>	6630.425** (7.265)	6551.439** (7.181)	0.039** (13.144)	-3.150 (-0.43)	5914.867** (6.335)
<b>Receptions</b>	10530.139** (11.154)	10612.350** (11.241)	0.026** (8.659)	29.612** (3.467)	12166.840** (12.78)
<b>EPC</b>	<b>392.265** (9.689)</b>		<b>0.001** (10.505)</b>	<b>3.981** (10.377)</b>	
<b>B</b>		<b>19439.000** (4.893)</b>			
<b>C</b>		<b>9118.500** (5.723)</b>			
<b>D</b>		<i>holdout</i>			
<b>E</b>		<b>-2815.704** (-2.325)</b>			
<b>F</b>		<b>-9034.188** (-5.521)</b>			
<b>G</b>		<b>-19330.571** (-4.477)</b>			
<b>Apartment</b>	35787.953** (16.566)	33911.179** (15.05)	0.098** (13.981)	497.262** (24.348)	
<b>Detached</b>	61810.971** (34.217)	61669.729** (34.14)	0.219** (37.465)	544.165** (32.142)	
<b>S e m i - detached</b>	27022.165** (19.817)	26988.353** (19.801)	0.136** (30.713)	311.892** (24.155)	
<b>Terrace</b>	<i>holdout</i>				
<b>Garage</b>	12250.064** (9.351)	12221.680** (9.33)	0.056** (13.126)	87.215** (7.065)	16513.295** (12.734)
<b>Pre 1919</b>	12096.360** (6.455)	11383.829** (6.081)	0.036** (6.009)	108.297** (6.15)	
<b>1919-1944</b>	18209.170** (10.919)	17786.854** (10.672)	0.041** (7.56)	159.962** (10.124)	
<b>1945-1964</b>	5281.331** (3.593)	5128.095** (3.488)	0.013** (2.777)	36.271** (2.605)	
<b>1965-1980</b>	<i>holdout</i>				
<b>Post 1980</b>	-76.083 (-0.047)	177.201 (0.108)	0.029** (5.408)	-31.981* (-2.1)	
<b>New Builds</b>	10362.006** (4.305)	8344.538** (3.337)	0.068** (8.662)	50.599* (2.25)	

Variables	Linear Model I	Linear Model II	Semi-log Model	Price (per m <sup>2</sup> ) Model	Interactive Model
	B (t)	B (t)	B (t)	B (t)	B (t)
<b>Belfast</b>			<i>holdout</i>		
<b>Carrickfergus</b>	-24524.640** (-11.841)	-24367.084** (-11.763)	-0.066** (-9.81)	-199.166** (-10.152)	
<b>Castlereagh</b>	9218.239** (5.242)	9141.460** (5.192)	0.046** (7.988)	102.263** (6.138)	
<b>Lisburn</b>	-4210.839** (-2.638)	-4258.520** (-2.67)	-0.003 (-0.584)	-38.383* (-2.539)	
<b>Newtownabbey</b>	-21954.767** (-14.102)	-22037.895** (-14.158)	-0.063** (-12.458)	-189.433** (-12.843)	
<b>North Down</b>	8285.358** (4.846)	8257.139** (4.831)	0.034** (6.122)	60.185** (3.719)	
<b>EPC*Apartment</b>					<b>556.574** (18.272)</b>
<b>EPC*Detached</b>					<b>928.163** (29.395)</b>
<b>EPC*Semi-detached</b>					<b>389.556** (16.574)</b>
<b>EPC*Terrace</b>					<i>holdout</i>
<b>EPC*Pre1919</b>					<b>153.421** (4.566)</b>
<b>EPC*1919-1944</b>					<b>288.696** (9.65)</b>
<b>EPC*1945-1964</b>					<b>50.664 (1.941)</b>
<b>EPC*1965-1980</b>					<i>holdout</i>
<b>EPC*Post1980</b>					<b>-10.794 (-0.431)</b>
<b>EPC*New Builds</b>					<b>128.223** (3.796)</b>
<b>EPC*Belfast</b>					<i>holdout</i>
<b>EPC*Carrickfergus</b>					<b>-416.863** (-11.328)</b>
<b>EPC*Castlereagh</b>					<b>150.690** (4.83)</b>
<b>EPC*Lisburn</b>					<b>-91.377** (-3.309)</b>
<b>EPC*Newtownabbey</b>					<b>-374.350** (-14.014)</b>
<b>EPC*North Down</b>					<b>134.124** (4.492)</b>



Variables	Linear Model I	Linear Model II	Semi-log Model	Price (per m <sup>2</sup> ) Model	Interactive Model
	<b>B (t)</b>	<b>B (t)</b>	<b>B (t)</b>	<b>B (t)</b>	<b>B (t)</b>
<b>N</b>	6,671	6,671	6,671	6,671	6,671
<b>K</b>	18	22	18	17	17
<b>R<sup>2</sup></b>	0.707	0.708	0.686	0.324	0.693
<b>R<sup>2</sup></b>	0.706	0.707	0.685	0.322	0.693
<b>SSE</b>	39339.497	39307.575	0.1275113	372.7317457	40248.011

# Asking Price Model Results (Cont...)

Variables	Price (£)	%	Price (per m <sup>2</sup> )	%	Interactive	%
EPC	<b>392.265**</b>	<b>0.3</b>	<b>3.981**</b>	<b>0.3</b>		
EPC*Apartment	Detached properties command £928. However, this might be because of the bigger size of detached properties compared to others.				556.574**	0.4
EPC*Detached					<b>928.163**</b>	<b>0.7</b>
EPC*Semi-detached					389.556**	0.5
EPC*Terrace						
EPC*Pre 1919						153.421**
EPC*1919-1944			<b>288.696**</b>	<b>0.1</b>		
EPC*1945-1964			50.664	0.0		
EPC*1965-1980						
EPC*Post 1980					-10.794	0.1
EPC*New Build					128.223**	0.2

**Note:**

Size, bedrooms, receptions, garage, type, age, and location are excluded in the table due to space limitations and to allow emphasis on the EPC effects.

\*\*Denotes significant at the 0.01 level (2-tailed).

\*Denotes significant at the 0.05 level (2-tailed).

There is a green premium of approximately £392 or £4 per m<sup>2</sup> or 0.3% for each one point increase in EPC score.

Older properties command £289. Again, this might relate to the bigger floor areas in older properties.

# Asking Price Model Results (Cont...)



Apartments demand the highest with £663 for each increase in EPC score. This is true, as majority apartments are new builds, which are often associated with better EPC ratings.

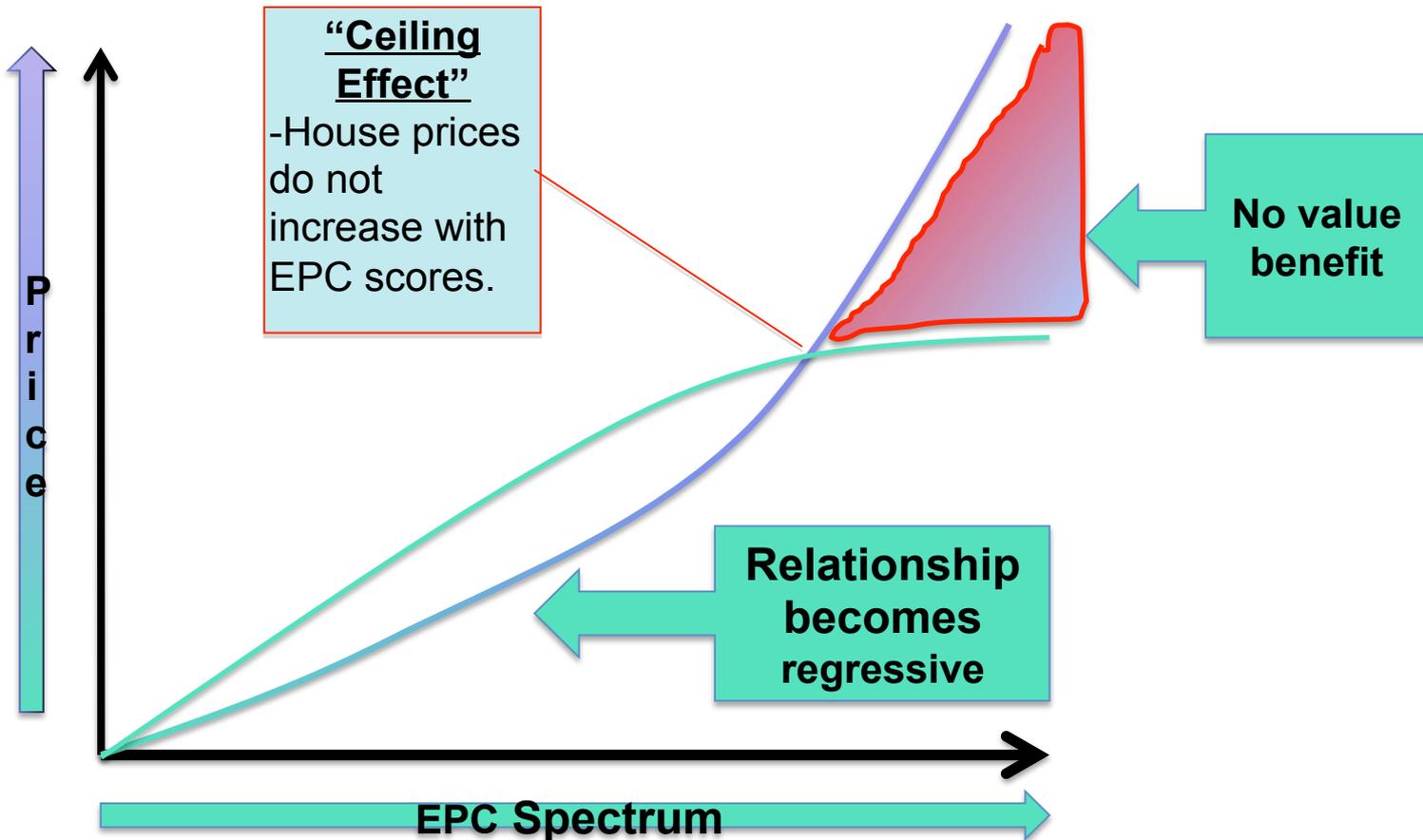
	Apartment	Detached	Semi-detached	Terrace
£	<b>662.577**</b>	493.597**	309.176**	274.450**

	Pre 1919	1919-1944	1945-1964	1965-1980	Post 1980	New Build
£	581.939**	410.012**	421.993**	327.006**	-7.284	<b>-554.176*</b>

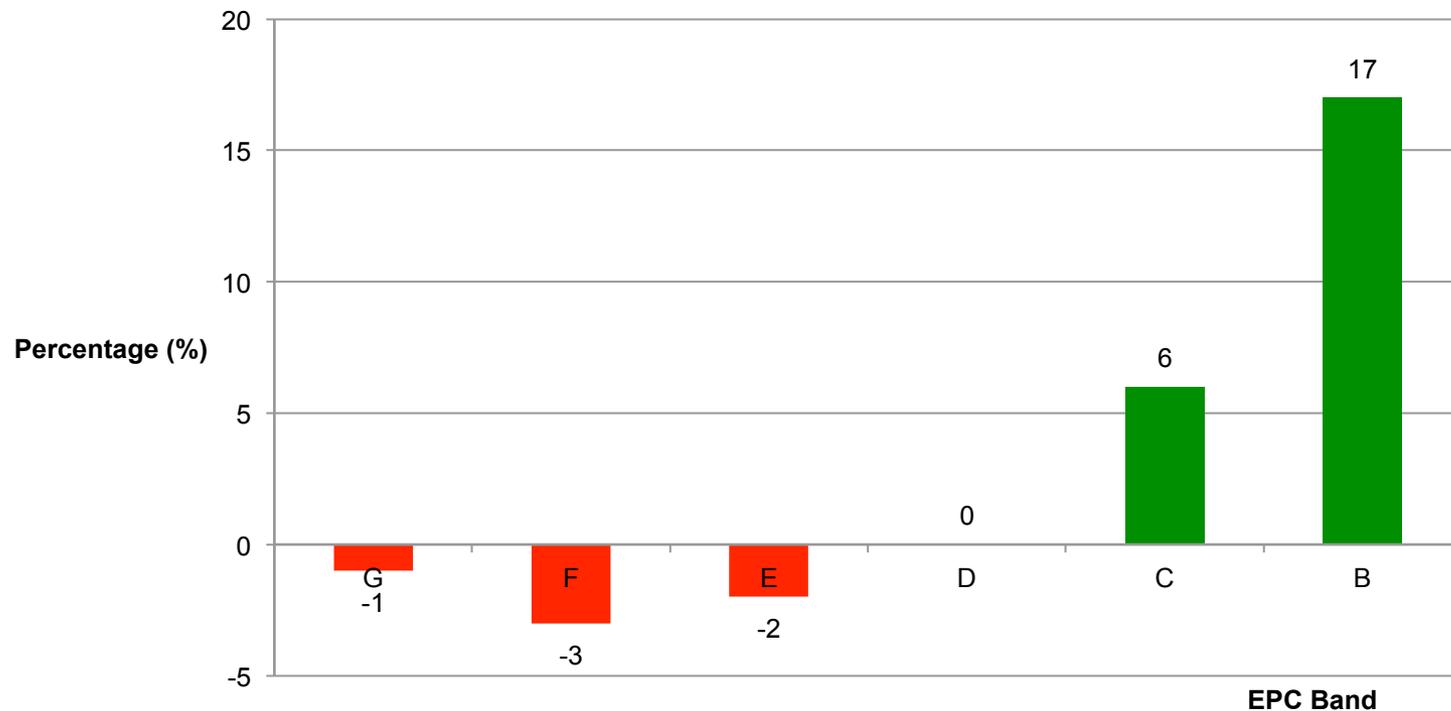
New buildings have price discounts of approximately £554 for each increase in EPC score. This suggests an evidence of “Ceiling Effect”.

# Asking Price Model Results (Cont...)

## The Ceiling Effect



# Asking Price Model Results (Cont...)



Variables	Linear Model I	Linear Model II	Semi-log Model	Rent (per m <sup>2</sup> ) Model	Interactive Model
	B (t)	B (t)	B (t)	B (t)	B (t)
<b>Intercept</b>	49.748** (4.314)	127.103** (14.322)	5.498** (305.146)	5.394** (24.72)	107.220** (12.541)
<b>Rent</b>					
<b>Size</b>	1.410** (16.231)	1.345** (15.445)	0.002** (15.33)		1.396** (15.969)
<b>Bedrooms</b>	123.163** (52.208)	123.808** (52.57)	0.184** (50.051)	0.502** (12.72)	125.045** (52.398)
<b>Receptions</b>	-4.070 (-0.906)	-3.927 (-0.877)	-0.001 (-0.136)	-0.599** (-7.231)	-6.062 (-1.34)
<b>EPC</b>	<b>1.307** (9.638)</b>		<b>0.002** (10.932)</b>	<b>0.022** (8.453)</b>	
<b>B</b>		<b>79.161** (7.808)</b>			
<b>C</b>		<b>29.328** (5.854)</b>			
<b>D</b>		<i>holdout</i>			
<b>E</b>		<b>-11.776** (-2.701)</b>			
<b>F</b>		<b>-23.635** (-3.955)</b>			
<b>G</b>		<b>-13.348 (-0.721)</b>			
<b>Apartment</b>	116.518** (22.885)	109.303** (20.609)	0.173** (21.768)	3.739** (39.769)	
<b>Detached</b>	51.753** (5.696)	51.422** (5.673)	0.101** (7.095)	0.466** (2.69)	
<b>S e m i - detached</b>	24.719** (4.492)	24.102** (4.393)	0.060** (7.019)	0.594** (5.578)	
<b>Terrace</b>	<i>holdout</i>				
<b>Garage</b>	43.736** (6.578)	44.711** (6.742)	0.075** (7.208)	0.076 (0.591)	38.532** (5.879)
<b>Pre 1919</b>	-36.368** (-5.117)	-34.109** (-4.786)	-0.037** (-3.338)	-1.778** (-13.218)	
<b>1919-1944</b>	-40.690** (-6.537)	-39.322** (-6.334)	-0.054** (-5.579)	-1.183** (-9.828)	
<b>1945-1964</b>	-41.925** (-6.911)	-42.530** (-7.022)	-0.054** (-5.719)	-1.201** (-10.229)	
<b>1965-1980</b>	-26.268** (-5.248)	-26.990** (-5.406)	-0.045** (-5.71)	-0.614** (-6.339)	
<b>Post 1980</b>	<i>holdout</i>				
<b>New Builds</b>	0.556 (0.067)	0.749 (0.09)	0.013 (0.97)	-1.397** (-8.67)	

Variables	Linear Model I	Linear Model II	Semi-log Model	Rent (per m <sup>2</sup> ) Model	Interactive Model
	B (t)	B (t)	B (t)	B (t)	B (t)
<b>Belfast</b>			holdout		
<b>Carrickfergus</b>	-106.771** (-11.618)	-108.507 (-11.829)	-0.178** (-12.394)	-1.384** (-7.778)	
<b>Castlereagh</b>	-24.698** (-3.206)	-24.343 (-3.167)	-0.031** (-2.569)	-0.471** (-3.156)	
<b>Lisburn</b>	-68.659** (-10.666)	-67.583 (-10.512)	-0.106** (-10.52)	-0.978** (-7.853)	
<b>Newtownabbey</b>	-102.270** (-15.409)	-101.581 (-15.341)	-0.170** (-16.347)	-1.259** (-9.795)	
<b>North Down</b>	-21.235** (-2.618)	-20.539 (-2.539)	-0.039** (-3.109)	-0.912** (-5.846)	
<b>EPC*Apartment</b>					2.098** (30.541)
<b>EPC*Detached</b>					0.674** (3.925)
<b>EPC*Semi-detached</b>					0.311** (3.112)
<b>EPC*Terrace</b>					holdout
<b>EPC*Pre1919</b>					-0.180 (-1.758)
<b>EPC*1919-1944</b>					-0.449** (-4.448)
<b>EPC*1945-1964</b>					-0.520** (-5.111)
<b>EPC*1965-1980</b>					-0.250** (-2.851)
<b>EPC*Post1980</b>					holdout
<b>EPC*New Builds</b>					0.139 (1.169)
<b>EPC*Belfast</b>					holdout
<b>EPC*Carrickfergus</b>					-1.726** (-11.168)
<b>EPC*Castlereagh</b>					-0.356** (-2.704)
<b>EPC*Lisburn</b>					-1.052** (-9.682)
<b>EPC*Newtownabbey</b>					-1.697** (-14.953)
<b>EPC*North Down</b>					-0.340** (-2.483)

Variables	Linear Model I	Linear Model II	Semi-log Model	Rent (per m <sup>2</sup> ) Model	Interactive Model	EPC Model
	<b>B (t)</b>	<b>B (t)</b>	<b>B (t)</b>	<b>B (t)</b>	<b>B (t)</b>	<b>B (t)</b>
<b>N</b>	3,928	3,928	3,928	3,928	3,928	3,928
<b>K</b>	18	22	18	17	17	
<b>R<sup>2</sup></b>	0.655	0.658	0.645	0.512	0.647	
<b>R<sup>2</sup></b>	0.654	0.656	0.643	0.510	0.645	
<b>SSE</b>	104.846	104.534	0.1638192	2.0309311	106.134	

# Asking Rent Model Results (Cont...)

Variables	Price (£)	%	Price (per m <sup>2</sup> )	%	Interactiv e	%
EPC	<b>1.307**</b>	<b>0.2</b>	<b>5.394**</b>	<b>0.3</b>		
EPC*Apartment					<b>2.098**</b>	<b>0.7</b>
EPC*Detached					0.674**	0.0
EPC*Semi-detached					0.311**	0.1
EPC*Terrace						
EPC*Pre 1919					-0.180	-0.2
EPC*1919-1944					<b>-0.449**</b>	<b>0.2</b>
EPC*1945-1964					<b>-0.520**</b>	<b>-0.2</b>
EPC*1965-1980					<b>-0.250**</b>	-0.2
EPC*Post 1980						
EPC*New Build					0.139	-0.2

Apartments command £2.10 which is a lot higher than other types of property.

There is a green premium of approximately £1.31 or £5.39 per m<sup>2</sup> or 0.3% for each one point increase in EPC score.

Older properties exhibit discounts.

**Note:**

Size, bedrooms, receptions, garage, type, age, and location are excluded in the table due to space limitations and to allow emphasis on the EPC effects.

\*\*Denotes significant at the 0.01 level (2-tailed).

\*Denotes significant at the 0.05 level (2-tailed).

# Asking Rent Model Results (Cont...)

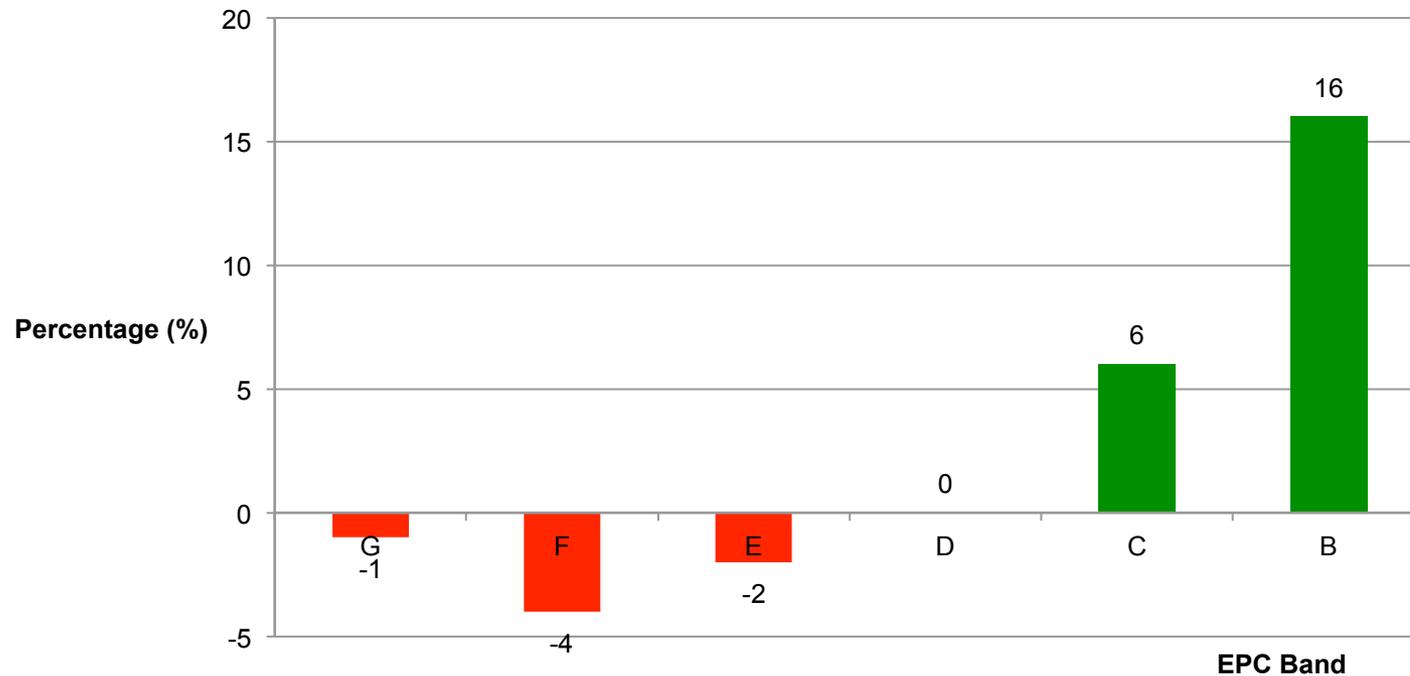
Apartments demand the highest with £2.04 for each increase in EPC score. This is true, as majority apartments are new builds, which are often associated with better EPC ratings.

	Apartment	Detached	Semi-detached	Terrace
£	<b>2.043**</b>	0.667	0.234	1.163**

	Pre 1919	1919-1944	1945-1964	1965-1980	Post 1980	New Build
£	-0.868	0.815*	1.261**	1.049**	1.537	<b>2.039*</b>

New buildings have the largest premium of approximately £2.04 for each increase in EPC score.

# Asking Rent Model Results (Cont...)



# Conclusion



1. There is a green premium (£392 or £4.00 per m<sup>2</sup> or 0.3%) in the property sales market → supports the literature:
  - Cajias and Piazzolo (2013)- 0.45%
  - Fuerst et al (2015)- 0.1%
  - McCord et al (forthcoming)- £420, £4.34 psm, 0.40%
2. There is a green premium (£1.31 or £5.39 per m<sup>2</sup> or 0.3%) in the property rental market.
3. The 'green' premium effect is arguably endogenous with property size, age, and type.
4. There is a ceiling effect.
5. Identify the demand and potential for green houses, stimulate sustainable property market, assist decisions.

# End of Presentation



## Thank you...