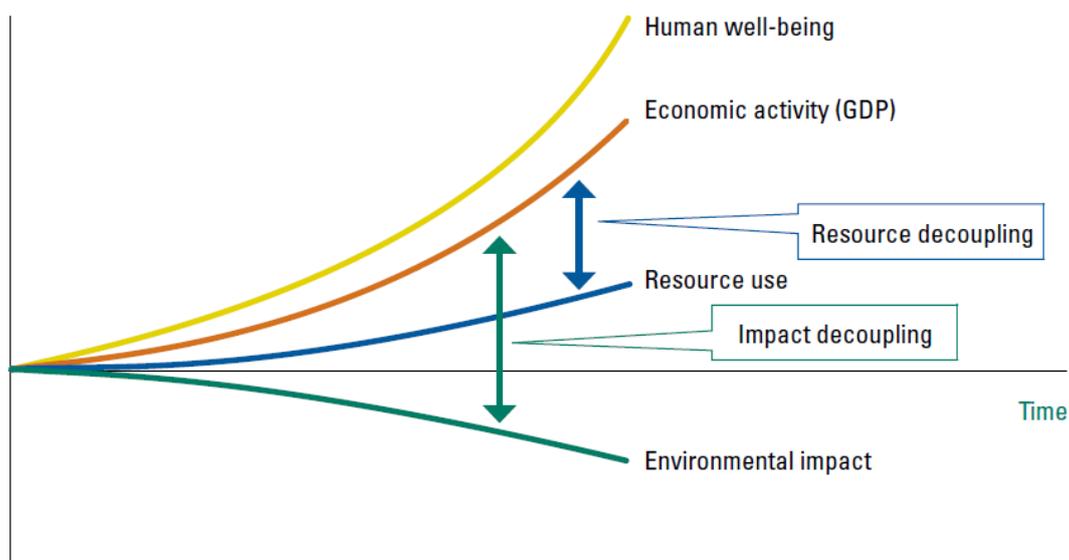


# Decoupling of Waste and Economic Indicators



This report is the deliverable of WRAP's *Decoupling of Waste and Economic Indicators* project. The project seeks to investigate decoupling of waste from economic growth, macro-level drivers of waste arisings and consider waste prevention measures.

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Front cover photography: Representation of decoupling: resource and impact decoupling [UNEP (2011).]

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# Executive summary

## Introduction

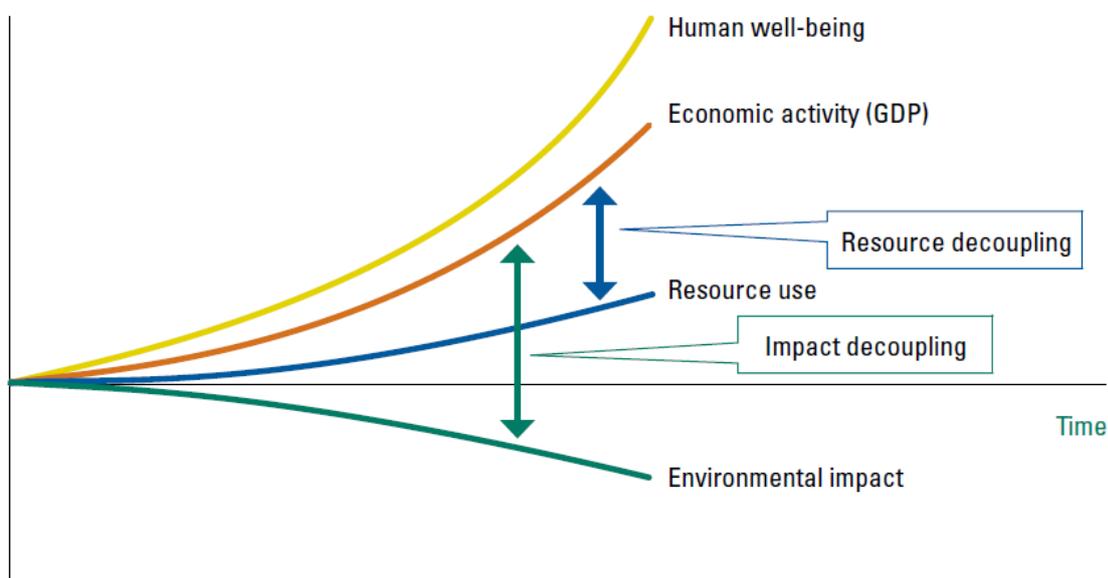
In 2010, the European Commission launched Europe 2020, a 10-year strategy for advancement of the economy of the European Union. It aims at "smart, sustainable, inclusive growth". This includes a flagship initiative on a resource efficient Europe, which recognises the need to decouple economic growth from resource use. At the same time, the 2008 Waste Framework Directive requires Member States to develop waste prevention programmes by the end of 2013, with the aim of decoupling economic growth from the environmental impact associated with the generation of waste.

This report seeks to investigate the key trends and drivers of waste arisings in the UK nations and the effectiveness of various waste prevention measures in reducing waste at the same time as facilitating economic growth.

## Decoupling

Historical trends in most industrial economies show that resource use and the resulting waste generation is linked to economic activity. However, it has been demonstrated that it is possible to de-link economic growth from resource use through resource efficiency by "doing more with less". Decoupling implies using less resources and generating less waste per unit of economic activity, as illustrated by Figure i.

**Figure i** Representation of decoupling: resource and impact decoupling (UNEP, 2011)



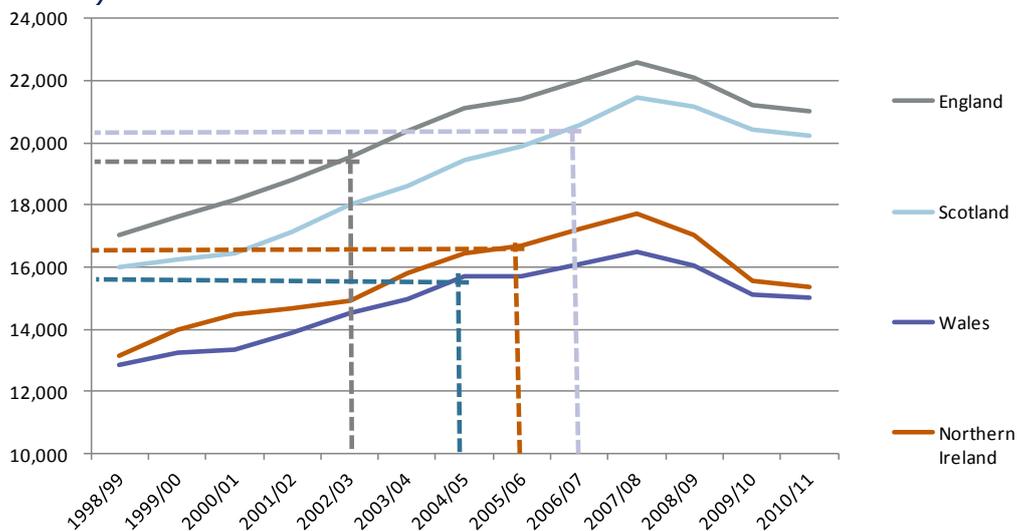
## What are the current trends in waste arisings and decoupling?

This research investigated trends of household, commercial, industrial, and construction and demolition waste arisings and key economic indicators in England, Scotland, Wales and Northern Ireland to see where decoupling has occurred.

### Household waste stream

In all nations, household waste arisings peaked between 2003 and 2007 and started to fall before the start of the current recession as shown in figure ii. This is strong evidence of decoupling, and is aligned with the waste Kuznets curve hypothesis<sup>1</sup>, which suggests that, once GDP reaches a certain level, waste arisings will start to reduce (i.e. decoupling of waste from GDP occurs).

**Figure ii** UK nations total Gross Value Added<sup>2</sup> (2010 £) per capita compared to first year of fall in Household waste arisings (broken lines indicate points at which waste per capita started to fall)



Source: GVA – ONS website - Regional Gross Value Added, annual figures

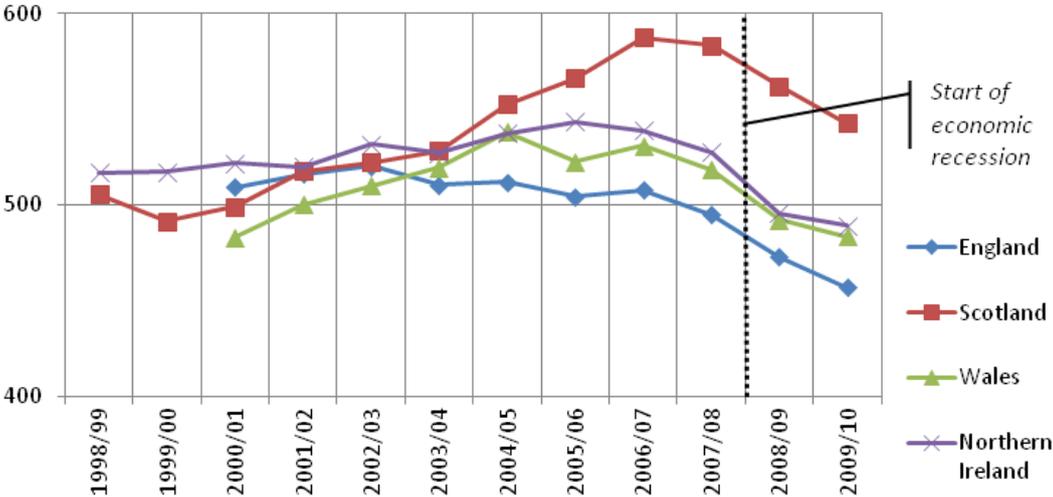
Furthermore, waste generation has continued to fall since the recession, both in real terms and relative to the amount that households spend.

<sup>1</sup> The environmental Kuznets curve hypothesis suggests that an economy tends to degrade its environmental quality during its initial economic growth, but that beyond a threshold point in its economic growth its environmental quality then starts to improve as per-capita income continues to grow (i.e. environmental impact indicator is an inverted U-shaped function of income per capita) (Van Alstine and Neumayer, 2009).

<sup>2</sup> Gross value added (GVA) is a measure of the value of goods and services produced in the economy. At a nation level it is broadly representative of GDP.

However, Figure iii shows that there is a marked difference between the nations with the average person in Scotland producing 100kg more waste per year than in England. Part of this difference may stem from the systems of waste collection and measurement methodology in Scotland, but it may also be due to comparatively high levels of Gross Domestic Household Income and Household Expenditure in Scotland.

**Figure iii** Household waste (kg per capita)



The reductions and varying levels of waste arisings across the UK indicate that there are opportunities to reduce household waste across the UK further. Waste Household waste appears to be reducing irrespective of trends in income and expenditure, suggesting that it can be done in a way that does not harm the economy.

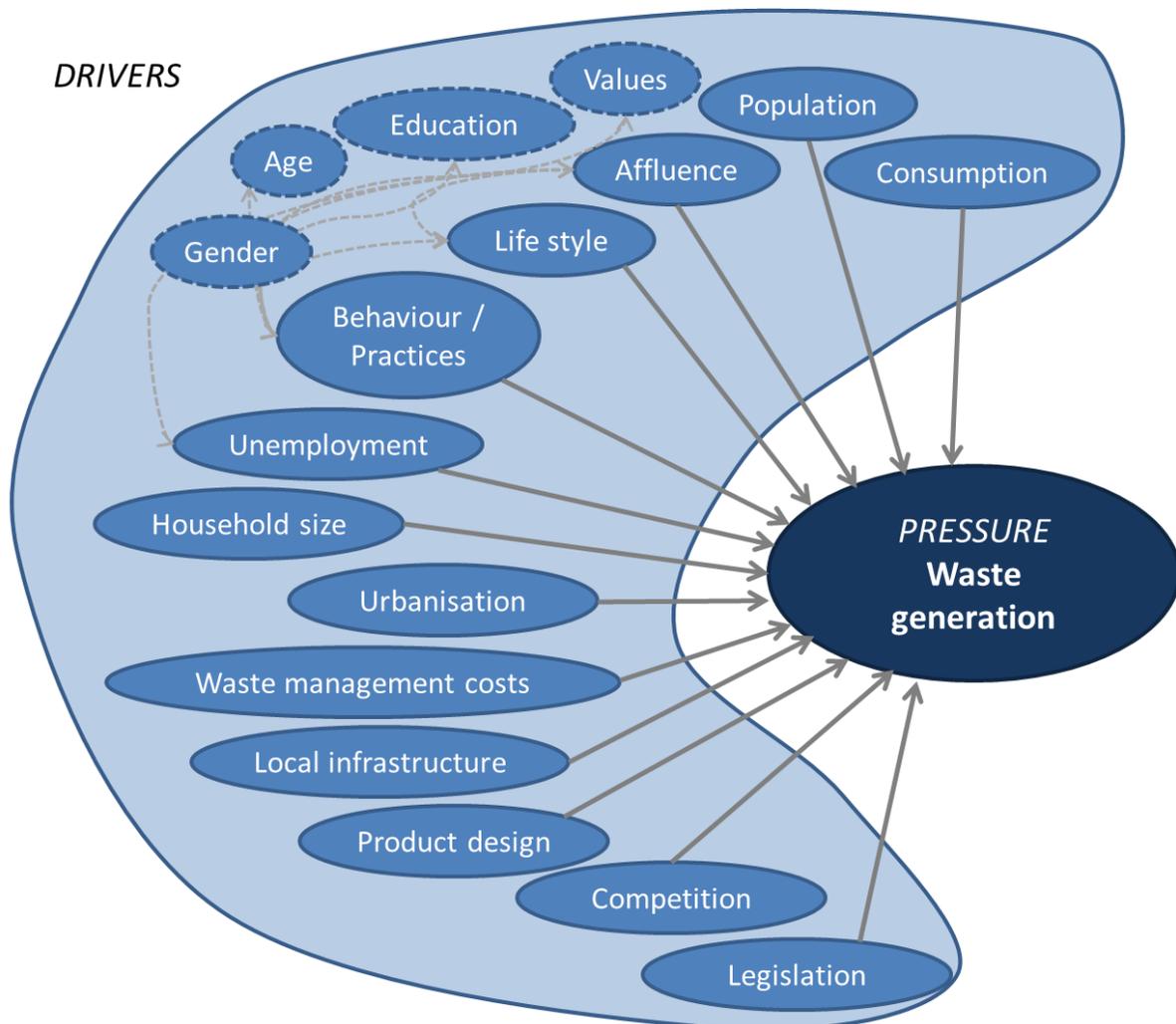
**Commercial, industrial, and construction and demolition wastes**

In all nations, commercial, and construction, Gross Value Added rose until the recession. Industrial Gross Value Added fell from 1998/99 to 2005/06 in all nations, prior to the recession, at which time it began to rise. In England and Wales this rise halted shortly after the recession, whereas it continued to rise in Scotland. However, lack of data and issues with the data (such as variation in the definitions of wastes and variance in waste collection across countries/time), present too much uncertainty in the trends of arisings of Local Authority Collected Waste (municipal waste), commercial and industrial wastes, and construction and demolition waste; it is not possible to derive any reliable conclusions on the relationship between waste and the economic performance of the sectors.

## What are the drivers for waste arisings?

The literature suggests that there are many drivers that have positive or negative effects on waste arisings. For example, an increase in population increases waste arisings, whereas an increase in waste management costs decreases waste arisings. These are summarised in Figure iv.

**Figure iv** Overview of drivers of change in waste arisings



Regression analysis has been carried out relating to drivers of household waste across the UK. The regression suggests that drivers include:

- household size, with smaller households generating more waste per capita;
- increased household expenditure on snack and takeaways which increase waste arisings; and
- the Landfill Tax, which has the effect of slightly reducing Household wastes arisings, contradicting the findings in the literature.

The findings suggest that economic instruments (e.g. Landfill Tax) may drive reductions in household waste.

## What measures can be taken to enhance decoupling?

There is evidence that waste prevention measures are effective to decouple waste, but the evidence does not allow conclusions to be drawn on which measure or combination of measures is most effective; this will depend on an individual context, waste stream and sector.

The evidence suggests that economic instruments (e.g. taxes, fees, and extended producer responsibility schemes), cooperation (e.g. voluntary and industry agreements) and information based instruments (e.g. ecolabels) may be effective in supporting decoupling. For co-operation to support decoupling, it should include clear targets relating to waste prevention, beyond diversion from landfill (i.e. prevention and reuse).

## Conclusions and Recommendations for further investigation

The report identifies trends in the relationship between household waste and economic indicators, and finds that other drivers are also important in determining the level of waste arising, with decoupling occurring across England, Wales, Scotland and Northern Ireland. Due to insufficient data, the same level of analysis could not be carried out for other waste streams.

There is evidence that waste prevention measures such as economic instruments, co-operation and information are effective in decoupling waste from economic drivers, but the evidence does not allow conclusions to be drawn on which measure or combination of measures is most effective; this will depend on an individual context, waste stream and sector.

The limits to the approach taken in this research could be overcome through access to more regular primary information on waste arisings for commercial, industrial and construction and demolition waste; however, there is currently no system in place for gathering comprehensive and reliable waste arisings data.

The approach taken to identifying "effective" waste prevention measures may be more valuable for specific products, as waste prevention measures are often designed and implemented to target one "gesture" or one type of waste (e.g. food). In addition, analysing data at a disaggregated level may prove more effective, as measures may be implemented at a local (municipal or regional) level.

Where different mixes of measures are considered, impact assessments should be carried out, taking into account rebound and windfall effects. Consideration of the rebound and windfall effects can aid in the design of waste prevention strategies which seek to achieve decoupling of waste from economic growth, and to ensure a full understanding of intended and unintended consequences of measures.

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## Abbreviations

AWC	Alternate Weekly Collection
C&D	Construction and demolition
CA	Civic Amenity
DEU	Domestic Extraction Used
DMC	Domestic Material Consumption
DMI	Direct Material Input
DPSIR	Drivers-Pressures-State-Impact-Responses
ELVs	End of Life Vehicles
EMAS	Eco Management & Audit Scheme
GDHI	Gross Disposable Household Income
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GKEWM	Government spending on waste management
GPP	Green Public Procurement
GVA	Gross Value Added
HE	Household Expenditure
Hhld	Household
HWRC	Household Waste Recycling Centre
LACW	Local Authority Collected Waste
MPS	Mail Preference Service
MS	Member States
MSW	Municipal Solid Waste
NACE	Statistical Classification of Economic Activities in the European Community
SCP	Sustainable Consumption and Production
SEPA	Scottish Environment Protection Agency
SIC	Standard Industrial Classification
WFD	Waste Framework Directive

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## 1.0 Introduction

This report seeks to investigate decoupling of waste from economic growth in the UK nations, macro-level drivers of waste arisings and the effectiveness of waste prevention measures, in order to understand actions that might increase the waste-efficiency of the economy.

This chapter provides an overview of the project context and definitions.

### 1.1 Waste prevention

EU waste policy has put an increasing focus on waste prevention. The Waste Framework Directive (2008/98/EC) (WFD) defines the waste hierarchy (Figure 1), positioning prevention at the top.

**Figure 1** The EU waste hierarchy



Waste prevention measures, as defined by the WFD, are measures taken before a substance, material or product has become waste. Such measures reduce:

- The quantity of waste, including through the re-use of products or the extension of the life span of products;
- The adverse impacts of the generated waste on the environment and human health; or
- The content of harmful substances in materials and products.

There is however a distinction between “reuse” and “preparation for reuse” in the Directive. The waste that is “prepared for reuse” (items that enter the waste stream but are then used again without recycling) is not considered as waste prevention.

Article 29 of the WFD requires Member States to establish waste prevention programmes by 12 December 2013, including setting objectives and monitoring progress via benchmarks. The waste prevention programmes should pursue the objective of de-linking economic growth and the environmental impacts associated with the generation of waste. This is generally known as “decoupling” (see section 1.2).

Prevention actions can reduce waste quantities generated throughout the life cycle of a product, from raw material extraction, through production, transportation, distribution, consumer use and end-of-life. Waste prevention is at the top of the waste hierarchy because it reduces waste generation at its source and ultimately results in resource conservation. This

study focuses on waste prevention in terms of weight, rather than environmental or health impact or hazard. The study therefore aims to prioritise actions that provide the greatest reductions in the weight of waste arisings.

Waste prevention also ties together climate change concerns and resource efficiency strategies. As examined in WRAP's 2009 report *Meeting the UK Climate Challenge*, 70% of possible greenhouse gas (GHG) reductions involve no additional cost and are achievable with current technologies.

The UK nations have developed unique waste strategies:

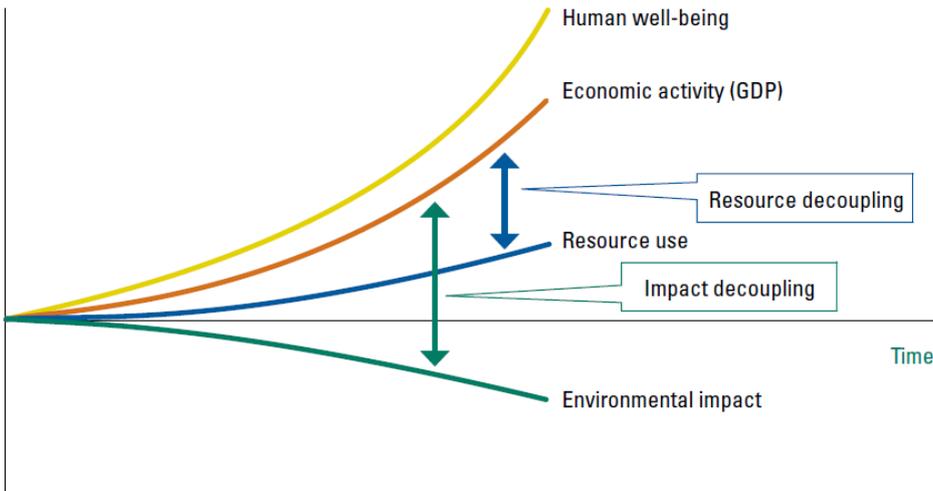
- England – *2007 Waste Strategy for England* (Defra, 2007)
- Scotland – *Scotland's Zero Waste Plan* (The Scottish Government, 2010)
- Wales – *Towards Zero Waste - One Wales: One Planet* (Welsh Assembly Government, 2010)
- Northern Ireland – *Towards Resource Management: The Northern Ireland Waste Management Strategy 2006 – 2020* (DOENI, 2006)

There is a lack of waste prevention targets in the current national strategies of the UK nations. This is discussed further in section 6.1. Wales is the only UK nation to have set a specific waste reduction target, although other strategic targets described may have an impact on waste prevention.

1.2 Decoupling

Historical trends in most industrial economies show that resource use (and the resulting waste generation) has been linked to economic activity (Fridolin et al., 2009). It has however been demonstrated that it is possible to de-link economic growth from resource use through resource efficiency by "doing more with less". Decoupling refers to the notion of de-linking economic growth from resource use and environmental pressure. Decoupling implies using less resources and generating less waste per unit of economic activity, as illustrated in Figure 2.

**Figure 2** Representation of decoupling: resource and impact decoupling (UNEP, 2011)

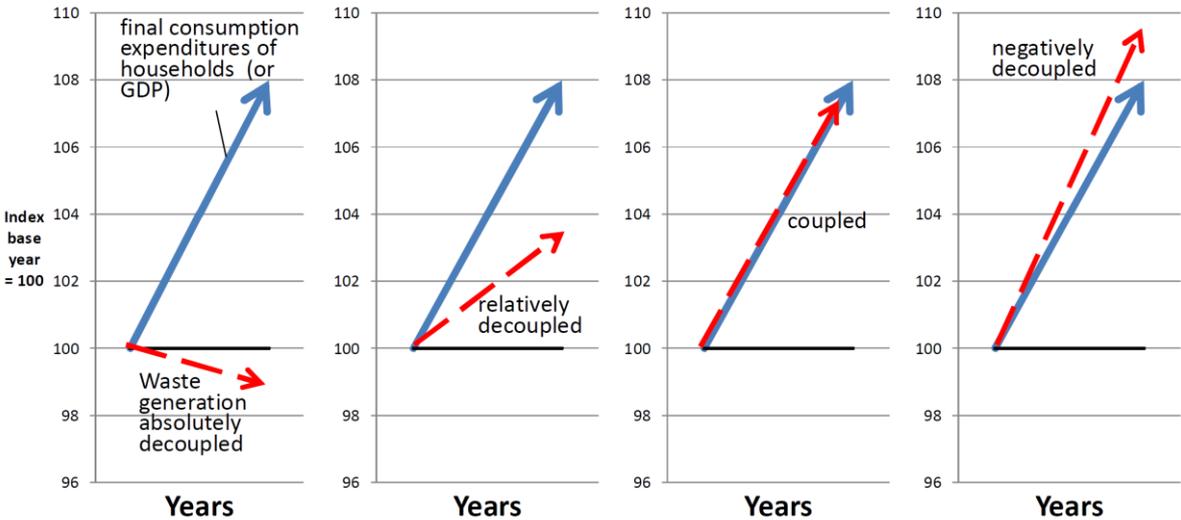


It is possible to measure the rate of decoupling by comparing the change in resource use with economic growth. The relationship between resource use or, in the context of this study, waste generation, can be described as:

- Absolutely decoupled (e.g. waste generation decreasing or remaining stable as economic indicator increases)
- Relatively decoupled (e.g. waste generation increasing, but at a lower rate than the increase in economic indicator)
- Coupled (e.g. waste generation increasing at the same rate as economic indicator)
- Negatively decoupled (e.g. waste generation increasing at a greater rate than the rate of increase in economic indicator)

While relative decoupling is a positive sign, the real aim is to achieve absolute decoupling, where the economy can continue to grow while waste generated reduces. Figure 3 provides graphic representations of the different definitions of decoupling.

**Figure 3** Decoupling (BIO Intelligence Service, 2011a)



In the context of a stagnant or shrinking economy only relative decoupling, where waste generation also decreases, can be achieved (Ekins and Speck, 2011). The current economic recession started with the “credit crunch” in August 2007, with the UK economy shrinking between July and September in 2008 (BBC, 2009).

Current evidence from the EU, UK and other countries show that relative decoupling occurred for municipal solid waste in the period 1995 to 2005. Based on waste statistics over the period 1975-1995 of richer OECD countries, Fischer-Kowalski and Amann found that absolute decoupling held for landfilled waste, but not total waste generated (Fischer-Kowalski and Amann, 2001). In the more recent years absolute decoupling of household waste has been observed in several countries. Article 9 of the WFD stipulates that the European Commission should explicitly set waste prevention and decoupling objectives for 2020 by the end of 2014.

Table 1 presents the results of analyses of decoupling of waste in the EU since 1995.

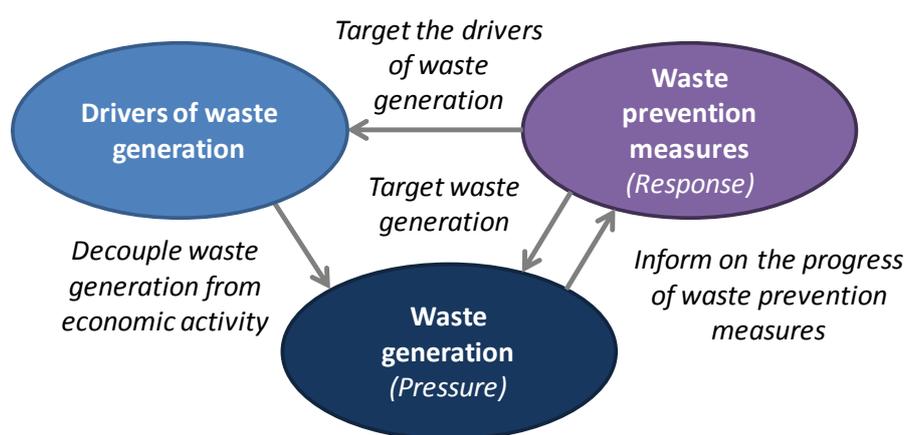
**Table 1** Evidence on Decoupling in EU Member States

Scope	With respect to population	With respect to GDP or household expenditure	Source and period
<b>EU27. Municipal waste</b>	-	Absolute decoupling	EEA (2010) 2003-2008
<b>UK. Municipal waste</b>			
<b>EU27. Municipal waste</b>	-	Relative decoupling	EEA (2009) 1997-2007
<b>UK. MSW</b>			
<b>EU25. Municipal waste</b>	Relative decoupling	Relative decoupling	Mazzanti and Zoboli (2009) 1995-2005
<b>Non household waste</b>	-	Relative decoupling for new MS, Greece, Spain and Belgium. Coupling or negative coupling for some old MS.	BIO Intelligence Service (2011a) 2004-2008
<b>Household waste</b>	-	Absolute decoupling for new MS. Western European Countries generally have a coupled situation, with exception of UK and Spain where waste volumes have stabilized. Denmark has negative decoupling.	BIO Intelligence Service (2011a) 2004-2008

In this report, the Drivers-Pressures-State-Impact-Responses (DPSIR) model<sup>3</sup> (EEA, 2003) is used as a conceptual framework for analysing decoupling of waste from economic activity (see Figure 4). Originally, used to classify and structure environmental indicators for policy use, it captures the three dimensions of this study:

- the key drivers of waste generation (e.g. economic activity, population, life styles, etc.);
- the pressure in the form of amounts and type of waste generated
- the responses in the form of waste prevention measures

**Figure 4** Analytical framework for this study - examines waste generation, its drivers and the effectiveness of waste prevention measures



Decoupling can be analysed by examining the trends of drivers and waste generation over time. The assessment of waste prevention measures can be carried out on the basis of how they influence drivers and/or waste generation itself.

<sup>3</sup> Drivers, Pressure, State, Impact and Response (DPSIR)

When assessing and implementing waste prevention measures, consideration should be taken for the potential rebound and windfall effects.

### 1.3 Rebound effect

Although increases in resource efficiency such as waste prevention can result in cost savings and environmental benefits, there is some evidence that efficiency gains by themselves do not result in an overall decrease of environmental pressure (Polimeni and Polimeni, 2006). When considering decoupling it is therefore important to consider the economic effects of waste prevention. One such effect is the so-called "rebound effect" that may occur with waste prevention measures.

The rebound effect is the potential for an increase in consumption to occur following an environmental efficiency intervention, which may reduce the overall anticipated environmental benefit of the intervention. For example, if a reduction in waste arisings leads to cost savings, this could lead to increased consumption, which might negate the overall environmental benefits. Rebound effects encompass both price induced, and mental/psychologically induced responses. The mental/psychological rebound effect is where a "feel-good" perception of being "green" encourages increased consumption of certain products where "green" or lower impact options are readily available.

Three types of price induced rebound effect are recognised in GVSS and BIO Intelligence Service (2011):

- Direct Rebound Effect – increased efficiency and associated cost reduction for a product/service results in its increased consumption because it is cheaper.
- Indirect Rebound Effect – savings from efficiency cost reductions enable more income to be spent on other products and services.
- Economy wide Rebound Effect – more efficiency drives economic productivity overall, resulting in economic growth and consumption at a macroeconomic level.

While rebound effects have been observed in energy efficiency, it is not clear to what extent rebound effects limit the potential for reducing waste. It has been estimated that the rebound effects of waste prevention strategies such as lifetime optimisation, reducing food waste and the restorative economy could be as high as 50% (WRAP, 2009). This was however linked with much uncertainty. Understanding the magnitude of any waste prevention rebound effect is important when developing policy interventions.

Further discussion on rebound effect is provided in section 6.4.

### 1.4 Windfall effect

Another economic effect that is important to consider with waste prevention measures is the windfall effect. The windfall effect (also referred to as the "deadweight effect") is a situation when an economic agent behaves in a certain way, and would have continued to behave in the same way even if the benefit had not been granted. The European Commission defines as a windfall effect "that would have occurred even if the public expenditure program did not exist". In the context of public policy, the windfall is a form of loss of public money since the costs associated with the implementation of policies could have been saved while achieving the target.

Further discussion on windfall effect is provided in section 6.5.

## 2.0 Aims, methodology and report structure

This project assesses waste arisings data for the UK nations, in order to map trends in arisings and compare these across the nations. Trends are compared against economic indicators to assess the extent of decoupling. The latest literature is reviewed to understand what factors may be driving trends in waste arisings. The drivers are analysed qualitatively and quantitatively to try to better understand their effect. Waste prevention strategies and measures are then reviewed, and evidence on the effectiveness of measures is drawn from the literature, focusing on priority waste streams.

**Chapter 1** provides an introduction to the report, an overview of the project context and definitions.

**Chapter 2** summarises the aims and methodology, and explains the report structure.

**Chapter 3** presents the available waste arisings data by waste stream, assesses its quality, and proposes a choice of data suitable for subsequent analysis. The waste arisings trends are mapped.

**Chapter 4** compares waste arising trends against trends of economic indicators, to qualitatively assess the extent of decoupling.

**Chapter 5** reviews and summarises the latest literature on the drivers of waste arisings, and sets out the quantitative and qualitative analysis of the drivers in order to better understand any variations between nations.

**Chapter 6** discusses selected waste streams, presents options for waste prevention strategies and measures (including examples of relevant measures and their impacts), and introduces considerations for their implementation, such as the benefits of combinations of measures, the rebound effect and the windfall effect.

The Appendices include references (Appendix 1), as well as definitions of the data, and additional analysis and evidence.

### 3.0 Waste arisings trends

This chapter examines and discusses the waste arisings data available, to understand its suitability for analysis of decoupling. Trends in waste arisings are also presented.

Waste arisings data are structured according to the following waste streams: household (Household), Local Authority Collected Waste (LACW), commercial, industrial, and construction and demolition (C&D).

#### 3.1 Suitability of the data for analysis

This chapter presents trends in waste arisings, and considers the differences in trends between the UK nations. Comprehensive data on LACW and Household waste is available for all of the nations from 2000, and for the late 1990s in some of the cases. Commercial, industrial and C&D waste surveys have been carried out periodically in the UK nations. However, considerable caution should be exercised in viewing this data in that:

- survey methodologies and definitions can vary;
- some reports submitted to Eurostat are built on indexing of data from previous surveys, as opposed to original sources;
- there are in some cases very low levels of precision; and
- the frequency of these surveys is variable and differs from country to country.

A commentary on these issues for waste arisings data can be found in [Table 2](#). In order to guide the conclusions that can be made from the data presented, a summary of issues related to the perceived levels of confidence associated with the data is given in this table, and referred to throughout this chapter.

One important change in definition was that LACW was previously referred to, in the UK, as Municipal Waste. However, this was changed to come into line with the Landfill Directive definition of Municipal Solid Waste (MSW), which includes waste of a similar nature but not collected by local authorities. In this document therefore, LACW refers to that material collected by Local Authorities, which was previously referred to as MSW. The term "Local Authority Municipal Waste" is currently used in Welsh reporting. For further detail on these definitions please see Appendix 2.

A key consideration on the use of data to create variables for commercial and industrial and C&D waste streams is the question of the inclusion, in a single variable, of data derived from different sources, whether primary data from surveys, or data modelled on previous survey data (secondary data)

The overriding considerations for inclusion of more than one source of data in variables are:

- The degree of similarity in methodologies and population;
- the level of confidence in the data;
- definitional changes;
- the methodology used to derive the data (particularly that submitted to Eurostat);
- the need for sufficient data points to enable an understanding of trends and to perform analysis; and
- whether it is primary or secondary data:
  - **primary data points** are derived by using survey data to create a model of waste arisings at a particular point in time based on actual tonnage figures from a representative sample; and
  - **secondary data points** are derived by indexing the primary data to estimates of the business population by sector and size band (using ONS data), and extrapolating the data to the desired point in time.

Comparison of primary data points can be considered to be an indicator of changes in waste arisings when a satisfactory conclusion can be drawn from consideration of these points; variation may be due to changes in population size or population behaviour.

Comparison of secondary data points can only suggest variation in arisings resulting from changes in population size. Business population size is strongly correlated with economic growth. Since this research aims to understand the extent of decoupling (or coupling) of waste arisings in relation to economic indicators, secondary data points derived from business population size cannot be considered as relevant indicators of any such coupling relationships. However, they can usefully enable changes in behaviour to be viewed in isolation from business population change in cases where both primary and secondary data is available. Caution should also be used in drawing conclusions from these secondary data points in that the further modelling on business population estimates could compound uncertainties in the original data, which in itself can have very high confidence intervals<sup>4</sup>.

An additional point to note is that some data was provided by calendar year. Such data has been entered in this report against the financial year with the greatest coincidence (e.g. 2002 data is shown as 2002/03).

## Data review and assessment

Table 2 gives the list of data sources used in the first column. Full references for these sources are provided in Appendix 1. In the second column there are observations on the robustness of each source. The third column considers the reliability of variables derived through the inclusion of these data. However, the cautionary points above should be born in mind throughout.

The level of commentary and understanding of the data sources is limited by the scope of this research. All key points of understanding on the data sources gathered during research are included, as well as input from stakeholders. However, there could be benefit in further research to better understand the relationship between these data sources. It must be recognised that the commentary in Table 2 remains general, aimed at highlighting the main points of difference.

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<sup>4</sup> However, it is interesting to note that SEPA (2009) tested their extrapolation method by comparing results for 2006 derived from 2004 data and the actual survey result in 2006. The estimates of total industrial and commercial waste produced in Scotland for 2006 differ by only 0.13% from the survey results, although there was greater variance for some categories. However, there have been substantial increases in the cost of raw materials, which may have driven this change, and this example covers only one data point, therefore the difference could be down to chance.

**Table 2** Data sources and reliability (see Appendix 1 for full references)

Source	Observations	Reliability of variables
<b>Household</b>		
<p>Sources:</p> <p><b>England</b> - Defra's Municipal Waste Management Survey (Defra, 1998-2011)</p> <p><b>Scotland</b> – SEPA Waste Data Digest (including updated - info from Julie Laing) (SEPA, 1998-2011) (Zero Waste Scotland, 2012)</p> <p><b>Wales</b> - Municipal Waste Management Survey for Wales (StatsWales, 2000-11)</p> <p><b>Northern Ireland</b> – Environment and Heritage Service, Municipal Waste Arisings Survey (EHS, 2002) (EHS, 2005) (EHS, 2006a) (EHS, 2007a) (EHS, 2008-11)</p>	<p>The data for the Household waste stream, shown in the chart below, is derived from actual recorded data (LA returns), as opposed to modelling based survey data. There were some changes to the definition of Household waste in Scotland during the relevant period. However, we have not been made aware of any significant concerns regarding comparability between years.</p> <p><i>In Wales there is a National Strategic Indicator, which is used to measure performance of local authorities at a national level, on the percentage of municipal waste collected by local authorities and prepared for reuse and/or recycled, including source segregated biowastes that are composted or treated biologically in another way. The definition is the same as that used in the quarterly statistical series, Local Authority Municipal Waste Management, but differs from the definition generally used within this bulletin (with the exception of Table 5). Consequently, there will be a difference in the figures reported. Additionally, in the past data quality issues have arisen related to the misspecification of data items in the returns and this has led to revisions of data for previous years. However, this mainly relates to information collected via the Municipal Waste Management Survey. More recently, misreporting of data is less of an issue, though it should be noted it is not always due to inaccurate reporting at the time, but may be due to incidents occurring which are out of the local authority's control.</i></p>	<p>We are not aware of any significant concerns regarding this data, which can be therefore be used for analysis</p>

Source	Observations	Reliability of variables
<b>LACW</b>		
<p>Sources:</p> <p><b>England</b> - Defra's Municipal Waste Management Survey (Defra, 1998-2011)</p> <p><b>Scotland</b> – SEPA Waste Data Digest (updated - info from Julie Laing) (SEPA, 1998-2011) (Zero Waste Scotland, 2012)</p> <p><b>Wales</b> - Municipal Waste Management Survey for Wales (StatsWales, 2000-11)</p> <p><b>Northern Ireland</b> – Environment and Heritage Service, Municipal Waste Arisings Survey (EHS, 2002) (EHS, 2005) (EHS, 2006a) (EHS, 2007a) (EHS 2008-11)</p>	<p>As with the Household stream, these values are based on actual data, and so can be considered to have a high level of reliability, especially since 2006/07 when all countries started to use the uniform reporting method for WasteDataFlow. Prior to this date each country had its own set of reporting requirements, including the level of inclusion of commercial waste in municipal stream. A consideration with LACW is that the ability of local authorities to distinguish commercial waste collected from household varies. Variations in the data may also be due to variance in the usage of commercial waste collections, as opposed to any measure of waste generation.</p> <p><i>In Wales there is a National Strategic Indicator, which is used to measure performance of local authorities at a national level, on the percentage of municipal waste collected by local authorities and prepared for reuse and/or recycled, including source segregated biowastes that are composted or treated biologically in another way. The definition is the same as that used in the quarterly statistical series, Local Authority Municipal Waste Management, but differs from the definition generally used within this bulletin (with the exception of Table 5). Consequently, there will be a difference in the figures reported. Additionally, in the past data quality issues have arisen related to the misspecification of data items in the returns and this has led to revisions of data for previous years. However, this mainly relates to information collected via the Municipal Waste Management Survey. More recently, misreporting of data is less of an issue, though it should be noted it is not always due to inaccurate reporting at the time, but may be due to incidents occurring which are out of the local authority's control.</i></p>	<p>Due to variation in service/uptake of commercial collections, and differences in definitions used, variation in this data beyond that seen in Household waste may be more to do with factors other than any changes in waste behaviours.</p> <p>Data can be included in review of overall arisings, but in assessing waste arisings collected by Local Authorities Household waste should be the prime indicator. LACW will not be included in the analysis of decoupling.</p>

Source	Observations	Reliability of variables
<b>Commercial and industrial</b>		
<p><b>England - survey data.</b> Sources:</p> <p>1998/99 - EA National Waste Production Survey (EA, 2005)</p> <p>2002/03 - Defra - Industrial and commercial waste arisings by business sector and waste type (Defra, 2006)</p> <p>2009/10 - Defra - Commercial and Industrial Waste Survey 2009, May 11 (Defra, 2011a)</p>	<p>The survey methods were similar in each case. However, the 2009 survey precision for the total waste arisings figure was 7.29Mt at a 90% confidence interval. In addition to this, it is estimated that there are around 2.5Mt of “non-wastes” not captured by the survey, specifically blast furnace slag and virgin timber. These are the equivalent of around 10% of this stream. However, it is not clear whether these were included in the previous surveys. Confidence intervals are not available for the other surveys.</p>	<p>The survey data is considered suitable for use in further analysis, although the cautionary notes above, possible impact of changed categories, and relatively high confidence intervals should be born in mind.</p> <p>The Eurostat data will also be reasonably accurate in predicting tonnage change according to change in business population, but cannot be considered an indicator of decoupling, and is therefore not included in the analysis beyond Chapter 3 (see notes above).</p>
<p><b>England – Eurostat</b></p> <p>Source: Defra - Total UK Waste Generation by Sector (Defra, 2011b)</p>	<p>Based on previous survey data indexed by business population. 2006 to 2008 reporting changed from NACE Rev 1.1 to NACE Rev 2. However, these changes have no implications on the overall categories of commercial, industrial, and C&amp;D waste.</p>	<p>The Eurostat data will also be reasonably accurate in predicting tonnage change according to change in business population, but cannot be considered an indicator of decoupling, and is therefore not included in the analysis beyond Chapter 3 (see notes above).</p>
<p><b>Scotland - survey data</b></p> <p>Source:</p> <p>SEPA and Napier University Edinburgh - Estimation of commercial and industrial waste produced in Scotland in 2004 and 2006 (SEPA, 2004, 2006 and 2009)</p>	<p>Both studies reported in this source are based on survey responses, using a similar methodology. The overall estimate was reported as 8.96Mt with a 95% confidence interval of 2.88 to 16.67 Mt.</p> <p>The 2006 survey results are reported as 7.64Mt 95% confidence interval of 2.60 to 13.42 Mt.</p>	<p>There are more data points for Scotland. Again, a consistent methodology was used in the surveys. Confidence intervals are high, but the methodology was tested against the SEPA estimates, suggesting that data is of a reasonable quality. This testing also</p>

Source	Observations	Reliability of variables
<b>Commercial and industrial</b>		
<p><b>Scotland - SEPA estimates</b></p> <p>Source: SEPA Business waste surveys 2005, 2007, 2008, 2009, 2010 (SEPA, 2005 – 2010)</p>	<p>The 2005 estimates are based on 2004 survey data and estimated as 8.42Mt of C&amp;I waste: 95% confidence interval 1.92 to 16.16Mt.</p> <p>The 2007, 2008, 2009 and 2010 results based on 2006 survey and business population. The reports state confidence intervals +/-11.8% for 2009 and +/-11.5% for 2010 but it's important to note that the confidence in the data was changed to 90%.</p>	<p>gives greater confidence in the SEPA estimates themselves.</p> <p>The Eurostat data and SEPA estimates will be reasonably accurate in predicting tonnage change according to change in business population, but cannot be considered an indicator of decoupling, and is therefore not included in the analysis beyond Chapter 3 (see notes above).</p>
<p><b>Scotland - Eurostat</b></p> <p>Source: Defra - Total UK Waste Generation by Sector (Defra, 2011b)</p>	<p>Based on previous survey data indexed by business population. 2006 to 2008 reporting changed from NACE Rev 1.1 to NACE Rev 2. However, these changes have no implications on the overall categories of commercial, industrial, and C&amp;D waste.</p>	
<p><b>Wales - survey data</b></p> <p>Source: EA Wales - Business waste surveys (1998/99) (EA Wales, 2001)</p> <p>EA Wales - Commercial and industrial waste survey Wales 2002/03 (EA Wales, no date)</p> <p>EA Wales - Survey of Industrial &amp; Commercial Waste Arisings in Wales 2007 (EA Wales, 2009)</p>	<p>The 2007, 2002/03 and 1998/99 studies were based on a consistent business survey methodology.</p> <p>In 2007 precision for the overall estimates at 90% confidence was +/-4.7%. In 2002/03 precision for the overall estimates at 90% confidence was +/-3.5%. The confidence intervals for 1998/99 were not available. The methodology was based on survey of businesses across Wales.</p> <p>Between 2002-03 and 2007, 1.8Mt of waste were reclassified as "non-wastes". As this is a large proportion of the industrial waste in Wales it was decided that non-wastes should be included in the 2007 survey data to better compare with the previous years. The value without non-wastes would compare with that given in the 2008/09 Eurostat data.</p>	<p>The three surveys in Wales used a consistent methodology. Some materials were reclassified as non-wastes before the last survey phase. The tonnages for these materials have been added back into the 2007/08 data for consistency. Confidence intervals for 2002/03 and 2007 suggest the survey data is suitable for inclusion in the dataset.</p> <p>The Eurostat data will also be</p>

Source	Observations	Reliability of variables
<b>Commercial and industrial</b>		
<p><b>Wales - Eurostat</b> Source: Defra - Total UK Waste Generation by Sector (Defra, 2011b)</p>	<p>Based on previous survey data indexed by business population. 2006 to 2008 reporting changed from NACE Rev 1.1 to NACE Rev 2. However, these changes have no implications on the overall categories of commercial, industrial, and C&amp;D waste.</p>	<p>reasonably accurate in predicting tonnage change according to change in business population, but cannot be considered an indicator of decoupling, and is therefore not included in the analysis beyond Chapter 3 (see notes above).</p>
<p><b>Northern Ireland - survey data</b> Source: Environment and Heritage Service - Industrial and commercial waste production in Northern Ireland 2002 (EHS, 2002)  Environment &amp; Heritage Service - Commercial &amp; Industrial Waste Arisings Survey 2004/05 (EHS, 2007b)</p>	<p>The 2002 study follows a survey methodology from previous studies. The confidence in results was between 0.51 and 0.76 Mt (+/-20%) (level of confidence not included).</p> <p>The 2004/05 study estimates 1.56Mt; confidence interval of between 0.46 and 3.18 Mt. There were differences in the methodology of the previous study which could account for some of the increase (greater than 0.17Mt). There were some data issues, including possibilities of double counting and miscoding. Levels of error were not included in the report. Therefore any comparisons should be made with great caution.</p>	<p>There are data from two surveys in Northern Ireland. There are issues with their comparability, as well as methodological problems. We have therefore not included Northern Ireland Commercial data in the further analysis.</p> <p>The Eurostat data will also be reasonably accurate in predicting tonnage change according to change in business population, but cannot be considered an indicator of decoupling, and is therefore not included in the analysis beyond Chapter 3 (see notes above).</p>
<p><b>Northern Ireland - NIEA estimates</b> Source: DOENI Northern Ireland 2008 C&amp;I Report: Comparing 2008 estimates with those from 2005/06 (DOENI, 2009a)</p>	<p>In 2008 the methodology was changed. The data was obtained from quarterly administrative returns submitted by the licensed facilities to NIEA. Therefore the data should not be directly compared with previous studies.</p>	<p>The Eurostat data will also be reasonably accurate in predicting tonnage change according to change in business population, but cannot be considered an indicator of decoupling, and is therefore not included in the analysis beyond Chapter 3 (see notes above).</p>
<p><b>Northern Ireland - WRAP estimates</b> Source: WRAP Northern Ireland Commercial &amp; Industrial (C&amp;I) Waste Estimates 2009 (WRAP, 2011a)</p>	<p>In 2009 study carried out by WRAP the estimates are based on applying factors (waste per business) derived from the Defra study covering England: C&amp;I waste survey 2009.</p> <p>Again the data should not be compared with previous studies.</p>	

Source	Observations	Reliability of variables
<b>Commercial and industrial</b>		
<p><b>Northern Ireland - Eurostat</b>  Source: Defra - Total UK Waste Generation by Sector (Defra, 2011b)</p>	<p>Based on previous survey data indexed by business population. 2006 to 2008 reporting changed from NACE Rev 1.1 to NACE Rev 2. However, these changes have no implications on the overall categories of commercial, industrial, and C&amp;D waste.</p>	

Source	Observations	Reliability of variables
<b>Construction and demolition</b>		
<p><b>England survey data</b></p> <p>Source: EA– Construction and Demolition Waste Survey: National survey of the production , recycling and disposal of construction and demolition waste in England and Wales 1999-2000 (EA, 2001)</p> <p>Office of the Deputy of the Prime Minister - Survey of Arisings and Use of Construction and Demolition Waste in England and Wales in 2001 (ODPM, 2002)</p> <p>Office of the Deputy of the Prime Minister - Survey of Arisings and Use of Construction, Demolition and Excavation Waste as Aggregate in England in 2003 (ODPM, 2004)</p> <p>Communities and Local Government - Survey of Arisings and Use of Alternatives to Primary Aggregates in England, 2005: Construction, Demolition and Excavation Waste (DCLG, 2007)</p>	<p>The results in this section are based on the surveys of operators of C&amp;D waste crushers and recycling centres, all licensed landfills allowed to receive C&amp;D waste or soil and holders of current Paragraphs 9 and 19 registered exemptions.</p> <p>The 1999 study has reported a confidence of level of 95% and confidence interval of +/-35% for the combined England and Wales estimate.</p> <p>The 2001 results have a confidence interval of +/-15% but this is for England and Wales combined. The 2003 results have a confidence interval of +/-10%. Both of these studies had a level of confidence of 90%. The total C&amp;D waste arisings value has a confidence interval of 9% at a confidence level of 90%.</p> <p>3 of the 4 studies were carried out by the same contractor and research team.</p>	<p>The surveys can be directly compared with each other, and are therefore included in further analysis. However it should be noted that the confidence intervals for the data are large, so that the results need to be viewed with more caution.</p> <p>DEFRA estimates are based on primary data, in the form of site returns, and are considered to have a reasonable level of reliability. However, the data is not comparable with previous studies, and is therefore not included in the variable for analysis.</p> <p>The Eurostat data will also be reasonably accurate in predicting tonnage change according to change in business population, but cannot be considered an indicator of decoupling, and is therefore not included in the analysis beyond Chapter 3 (see notes above).</p>
<p><b>England – DEFRA estimates</b></p> <p>Defra - Construction, Demolition and Excavation waste generation estimate: England, 2008 (Defra, 2010)</p>	<p>Estimates for 2008 - 2010 include excavation type waste. The information is in two categories - C&amp;D waste and excavation waste. This type of waste accounts for around 38-39% and is consistent between the three years reported. The data is based on EA site returns from transfer stations, treatment facilities and landfills, as well as Mineral Products Association (MPA) data and estimates of exempt waste.</p>	

Source	Observations	Reliability of variables
<b>Construction and demolition</b>		
	Confidence intervals are not included in the methodology. The data is therefore comparable between the three years but should not be compared with previous studies.	
<b>England - Eurostat</b> Source: Defra - Total UK Waste Generation by Sector (Defra, 2011b)	Based on previous survey data indexed by business population. 2006 to 2008 reporting changed from NACE Rev 1.1 to NACE Rev 2. However, these changes have no implications on the overall categories of commercial, industrial, and C&D waste.	
<b>Scotland – survey data</b> Source: SEPA - Construction and demolition wastes in Scotland reports of 2004, 2005, 2006, 2007, 2008, 2009 (SEPA, 2004-09)	<p>The 2004 - 2009 reports are based on data on C&amp;D wastes managed at sites with a waste management licence, pollution prevention and control (PPC) permit or exemption from waste management licensing.</p> <p>Data on C&amp;D wastes managed by authorised mobile plant were not included in this study. This is because waste managed by mobile plant may be double-counted if it is used for an exempt activity or managed at a licensed or permitted site after it has been treated. In addition, the material managed by mobile plant may not become waste if it is turned into aggregate and sent off-site as a product.</p> <p>The reports do not include confidence intervals so it's difficult to estimate reliability of the data.</p> <p>The methodology in the different years is consistent and therefore the results are comparable.</p>	<p>The methodology was consistent. Although confidence intervals are not given, the data can be considered to have a reasonable degree of reliability.</p> <p>The Eurostat data will also be reasonably accurate in predicting tonnage change according to change in business population, but cannot be considered an indicator of decoupling, and is therefore not included in the analysis beyond Chapter 3 (see notes above).</p>
<b>Scotland Eurostat</b> Source: Defra - Total UK Waste Generation by Sector (Defra, 2011b)	Based on previous survey data indexed by business population. 2006 to 2008 reporting changed from NACE Rev 1.1 to NACE Rev 2. However, these changes have no implications on the overall categories of commercial, industrial, and C&D waste.	
<b>Wales – survey data</b> EA – Construction and Demolition	Data from 1999 and 2001 were included in the England and Wales estimates based on survey of operators of different waste facilities (see above).	The survey data should be treated as less reliable, and comparisons

Source	Observations	Reliability of variables
<b>Construction and demolition</b>		
<p>Waste Survey: National survey of the production , recycling and disposal of construction and demolition waste in England and Wales 1999-2000 (EA, 2001)</p> <p>Office of the Deputy of the Prime Minister - Survey of Arisings and Use of Construction and Demolition Waste in England and Wales in 2001 (ODPM, 2002)</p> <p>Waste arisings by sector in Wales, kilotonnes per annum, 1998-99 to 2008-09 (StatsWales, 2012)</p>	<p>The 1999 study has reported a confidence of level of 95% and confidence interval of +/-35% for the combined England and Wales estimate.</p> <p>The 2001 results have a confidence interval of +/-15% but this is for England and Wales combined.</p> <p>The 2005 data from the 1998/99 to 2008/09 source is not comparable to previous years due to differing survey methodology.</p>	<p>between the studies should be made with caution as there are some methodology differences as well as the broad confidence intervals which could overlap. The 2004/05 StatsWales data included waste re-used on site, so that this cannot be compared to other surveys (no breakdown of the data available in order to address this difference).</p> <p>The EA company survey data are based on primary data, in the form of site returns, and are considered to have a reasonable level of reliability. However, the data is not comparable with previous studies and is therefore not included in the data for analysis.</p>
<p><b>Wales – companies survey</b></p> <p>EA Wales Building the future 2005-06: A survey on the arising and management of construction and demolition waste in Wales 2005-06 (EA Wales, 2007)</p>	<p>This data is based on survey returns of C&amp;D companies (demolition, construction, civil engineering and refurbishment companies in Wales). The survey resulted in a confidence interval of +/- 39% percent at 90% confidence level. This methodology differs from the previous studies, and includes waste re-used on site, therefore should not be compared with previous years' data.</p>	<p>The Eurostat data will have similar quality issues as the survey data, as it is modelled on that data and change in business population. It cannot be considered an indicator of decoupling, and is therefore not included in the analysis beyond Chapter 3 (see notes above).</p>
<p><b>Wales - Eurostat</b></p> <p>Source: Defra - Total UK Waste Generation by Sector (Defra, 2011b)</p>	<p>Based on previous survey data indexed by business population. 2006 to 2008 reporting changed from NACE Rev 1.1 to NACE Rev 2. However, these changes have no implications on the overall categories of commercial, industrial, and C&amp;D waste. The 2006/7 and 2008/9 Eurostat data is based on the 2005/6 survey excluding waste reused on site.</p>	
<p><b>Northern Ireland – survey data</b></p> <p>Environment and Heritage Service –</p>	<p>The 2001 study methodology covered surveys of the construction industry as well as licensed landfills, “Exempt” landfills, and C&amp;D waste crushers/screeners. This was not done in the subsequent surveys, and the data is very much greater. There</p>	<p>There are considerable differences in methodology between the surveys, so that this data is not suitable for</p>

Source	Observations	Reliability of variables
<b>Construction and demolition</b>		
<p>Construction and Demolition Waste Survey 2001 (EHS, 2003)</p> <p>Environment &amp; Heritage Service Survey of Arisings and Use of Construction, Demolition and Excavation Waste as Aggregate in Northern Ireland in 2004/05 &amp; 2005/06 (EHS, 2006b)</p> <p>DOENI - Northern Ireland 2008 CDEW Report: Comparing 2008 estimates with those from 2005/06 (DOENI, 2009b)</p>	<p>was a low level of confidence in the resulting data (nearly 6Mt range).</p> <p>The methodology for the 2004/05 and 2005/06 studies was slightly different. The organisations interviewed were: owners and potential users of mobile crushers and/or screens (for recycling into aggregate), licensed landfills and sites which had been registered with EHS as exempt from waste management licensing to permit the spreading of waste soil, rock and similar inert waste materials. For these two studies confidence intervals were only included for material sub-categories (recycled aggregate and soil recovered by crushing and/or screening, of [mainly] soil used or disposed of in licensed landfills and [mainly soil] used on registered exempt sites).</p> <p>The report also states that evidence of some temporary stockpiling of clean excavation waste suggests that the true figure for arisings in 2005/06 may be higher than the above estimate, which is based on the amounts of such materials reported by respondents to be either used or finally landfilled.</p> <p>The 2008 information comes from a combination of the analysis of site returns and the survey of registered exempt sites on which a separate report has been produced. The 2006 survey population of aggregate and soil recyclers covered work done on sites that are neither licensed nor exempt from licensing (as well as on licensed and exempt sites), and as a consequence the estimate was much higher than the more restricted 2008 figure. It is therefore not possible to make a direct comparison of the two estimates. It would therefore not be advisable to compare these studies due to methodology differences, low levels of confidence and the issues in 2005/06.</p>	<p>further analysis.</p>

### 3.2 Trends in waste arisings per waste stream at the UK nations level

All of the data available for each waste stream (from the sources listed in Table 2) is presented, alongside a discussion of the data quality. On the basis of this information, data has been selected for subsequent comparison of national trends and analysis of decoupling in Chapter 4, and an appropriate level of caution given for use of these data during this further analysis.

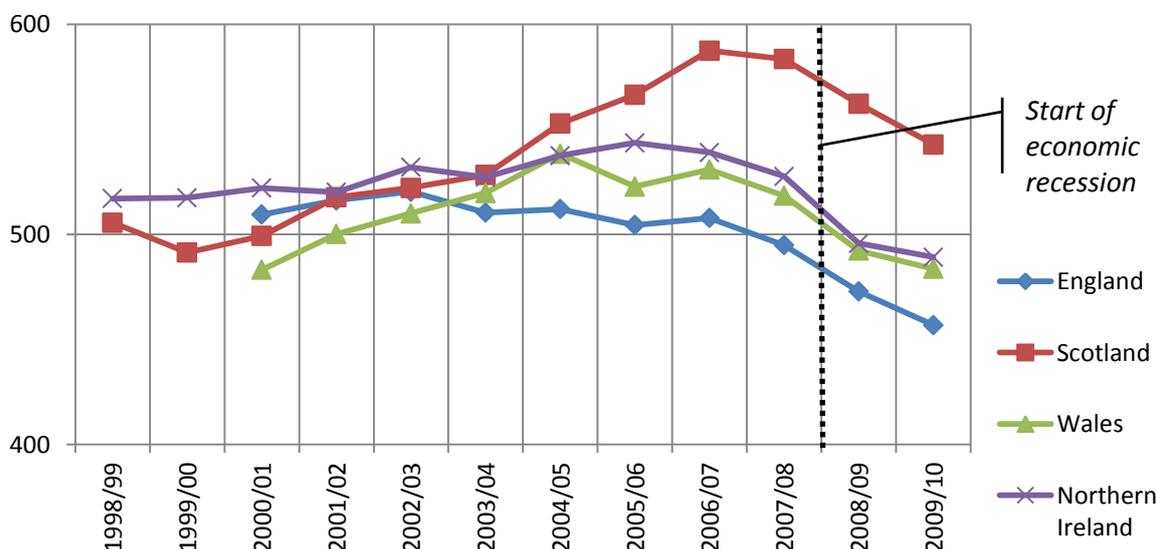
The commentary aims at highlighting the main points of difference in the data; it should be noted that the depth of investigation into the data sources is limited by the scope of the study. The cautionary points on primary and secondary data discussed earlier in this chapter, and on use of multiple sources to derive a data series, should be borne in mind throughout.

As discussed in section 3.1, the data available for commercial, industrial, and C&D waste streams are more varied and some data points are estimates<sup>5</sup>. Data for these streams are examined by nation. Data points drawn from survey sources (primary data) are shown in brown to distinguish these from values based on secondary data.

#### 3.2.1 Household waste

Although there are some definition changes across nations and time which lead to slight variation in the scope of the Household waste stream, the data collected is primary and considered suitable for inclusion in further analysis. The data is the sum of materials collected from households, including residual waste, recycling and composting, as well as CA site waste, and other household sources. Per capita values are used to enable comparison between nations.

**Figure 5** Household waste (kg per capita)



**Sources:**

SEPA, 1998-2011; Zero Waste Scotland, 2012

StatsWales, 2000-11

EHS, 2002; EHS, 2005; EHS, 2006a; EHS, 2007a; EHS 2008-11

Defra, 1998-2011

<sup>5</sup> Estimates are made through modelling, based on primary data from representative surveys (which often have high potential margins of error) and changes in the numbers of businesses in the sector.

Figure 5 suggests that Scotland has, in recent years, produced the highest levels of Household waste arisings per capita, while England has been producing the lowest levels. The trends are similar between the nations, with Household waste arisings reaching between 500 and 600kg per capita, before falling away. This change occurred prior to the economic recession in 2008. Part of this difference may stem from the systems of waste collection and measurement methodology in Scotland<sup>6</sup>:

- Particularly in more rural locations, Scottish Local Authorities collect more than just Household waste in their rounds and regularly operate mixed waste collections for Household, commercial and industrial waste.
- Scottish Local Authorities have to estimate and report the split of Household, commercial and industrial wastes. In earlier years, less attention was paid to the household/commercial waste split, thus it is likely that the Household waste figures in the graph include some commercial waste. Now that recycling targets are based on Household waste, more attention is placed on an accurate estimate of the split.

However, it is considered unlikely these artefacts of measurement methodology would be the only cause of this difference in the trends, given that the per capita waste in Scotland is consistently higher, and that the greatest difference is in recent years (during which time more attention has been paid to an accurate estimate of the household/commercial split<sup>6</sup>); therefore it is likely to also have been caused by other variables (e.g. economic, demographic or behavioural changes). These types of change are explored during the analysis of decoupling and assessment of waste drivers.

### *3.2.2 Local Authority Collected Waste*

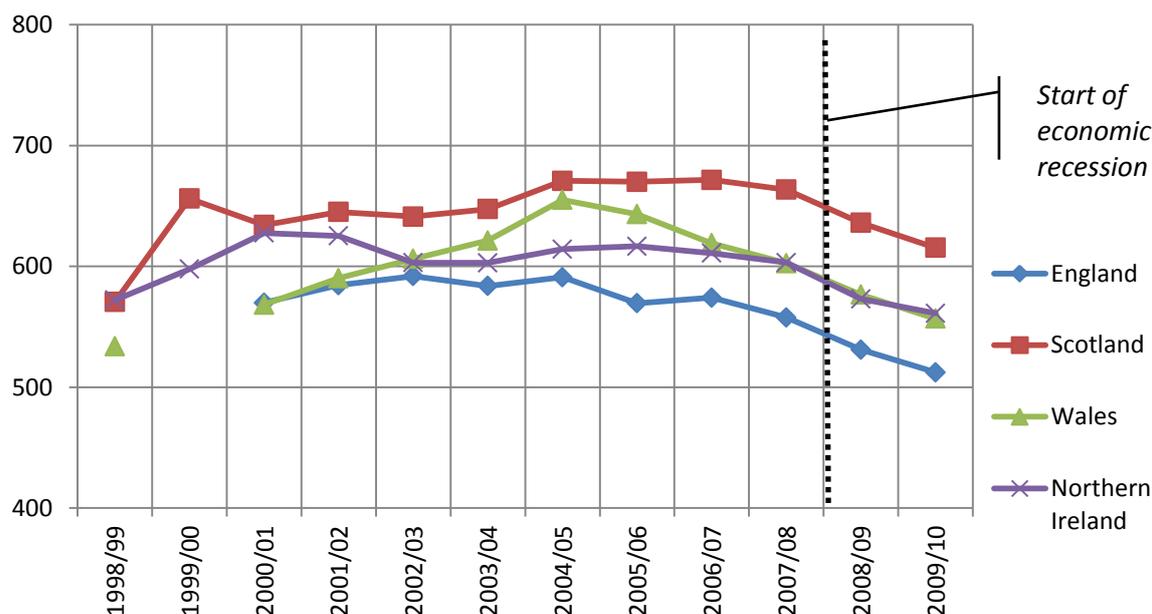
The meaning of LACW in this report is the sum of Household waste and all other waste collected by Local Authorities (in order to harmonise with the Landfill Directive a new definition was agreed in 2010 (Defra, 2011d) – see Appendix 2 for further detail). The other material includes commercial waste and recycling, as well as street cleaning, parks and other sources.

There are concerns with this primary data, due to the variations in definitions over the period reviewed and between UK nations (see section 3.2.1). While it is considered suitable for inclusion in comparison of overall arisings in this chapter, these concerns should be borne in mind in viewing suggested trends. The data is not however considered suitable for analysis of decoupling. Trends in LACW are shown in Figure 6.

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<sup>6</sup> Julie Laing, Zero Waste Scotland 17/9/12

**Figure 6** LACW (kg per capita)



**Sources:**

SEPA, 1998-2011; Zero Waste Scotland, 2012

StatsWales, 2000-11

EHS, 2002; EHS, 2005; EHS, 2006a; EHS, 2007a; EHS 2008-11

Defra, 1998-2011

Figure 6 suggests that the general trend is indeed similar to that of Household waste, and again the highest levels of LACW are in Scotland, and the lowest in England. However, unlike the trend in Household waste, Scottish LACW arisings per capita fall with the other countries at around the same period, and prior to the economic recession. Apart from potential variation due to changes in definitions (see Appendix 2), the difference in the gradients in the Scottish trends may stem from the systems of waste collection and measurement methodology in Scotland, as discussed in section 3.2.1. For example, this may be due to changes in the proportion of non-household waste in LACW in Scotland: For commercial waste, there was a reduction from 13.9% of LACW arisings in 2004/05 to 6.2% in 2010/11.

### 3.2.3 Commercial, industrial, and construction and demolition waste trends

There are less data available for the commercial, industrial, and C&D waste streams, and there is currently no system in place for gathering comprehensive data at regular intervals. Periodic waste generation surveys have been carried out in the UK nations, which provide estimates for those points in time. Estimates and data are submitted to Eurostat every other year in accordance with the requirements of the EC Waste Statistics Regulations. This data is sometimes the result of analysing or compiling data from that year, and sometimes it is modelled based on estimates from previous years (see section 3.1 for further discussion on the suitability of primary and secondary data for the purposes of the analysis).

The Environment Agency is leading on developing a system to capture and store data contained within Waste Transfer Notes, which have traditionally been retained in paper form (Environment Agency, no date). This system has the potential to provide good estimates on waste generation as it can hold basic data on all waste movements; however the system is voluntary and its success will depend on uptake by waste management companies and support from business.

In the following charts, the survey data points (primary data) are shown in blue to distinguish these from values based on secondary data.

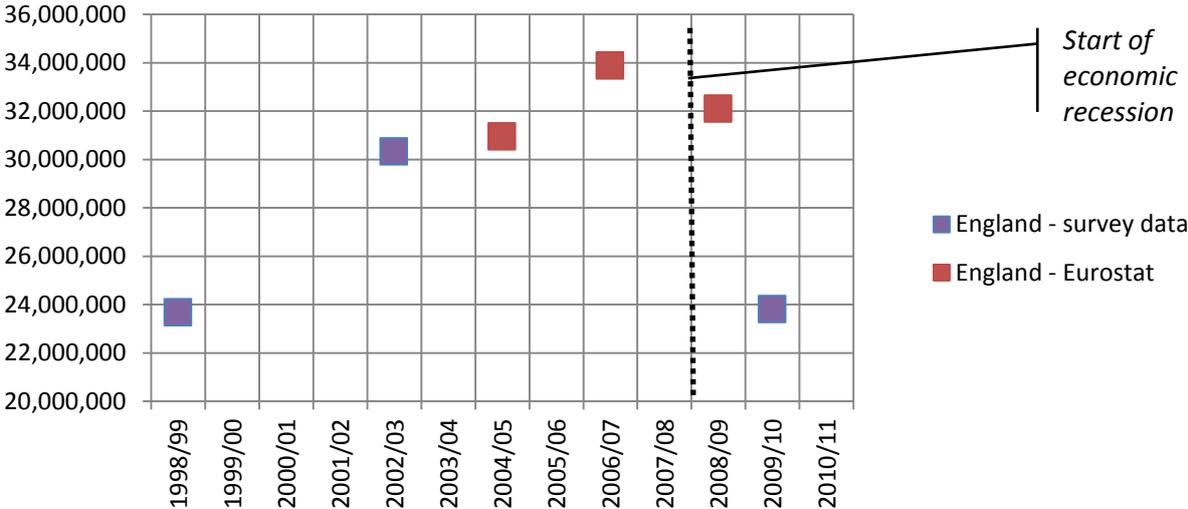
Throughout these sub-sections, data for each county and waste stream is given, with a summary of the information in Table 2. On the basis of this information, data has been selected for analysis, and an appropriate level of caution given for the use of these data for further analysis.

3.2.4 Commercial waste

England

Figure 7 shows commercial waste arisings for England. There are very few data points. The survey data is considered suitable for use in analysis of decoupling, although the possible impact of changed categories and relatively high confidence intervals should be born in mind. The Eurostat data predicts tonnage change according to change in business population, and cannot be considered an indicator of decoupling. We therefore include only survey data for further analysis of decoupling, although all interpretation based on this data should refer to the commentary in Section 3.1.

Figure 7 Commercial arisings England (in tonnes)



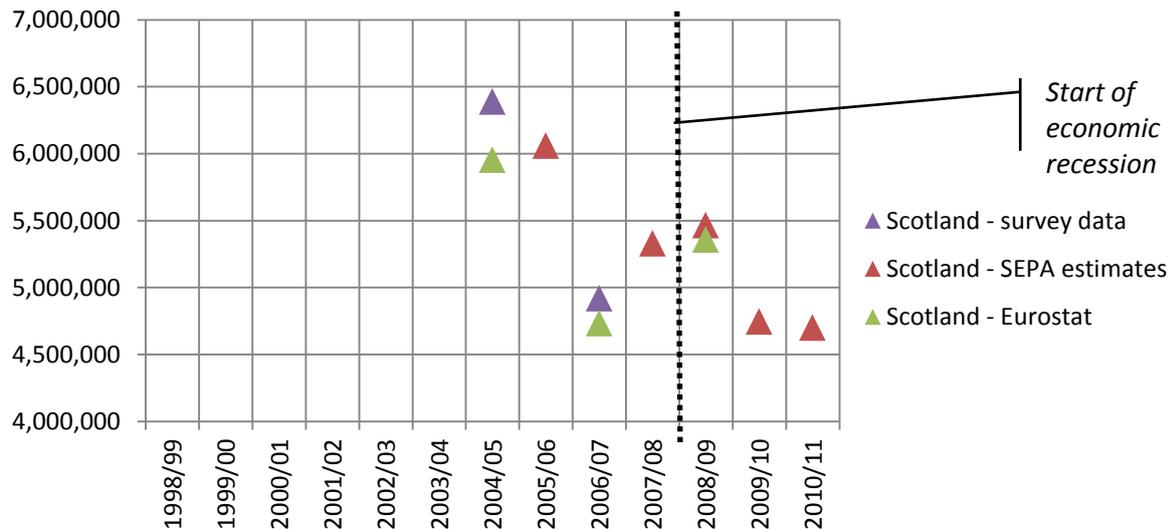
Sources: EA, 2005; Defra, 2006; Defra, 2011a; Defra, 2011b

The Eurostat data suggests a continuation of the direction of growth suggested by the first two surveys, but ending with the economic recession. The third survey suggests that between 2008/09 and 2009/10 there was an even stronger downturn in arisings. An alternative view might be that the Eurostat measure, on the basis of business population only, misses an actual change in behaviour, in that arisings per unit of commercial population may have reduced.

## Scotland

Figure 8 shows commercial waste arisings for Scotland. There are more data points for Scotland than England. A consistent methodology was used in the two surveys. Confidence intervals for the survey data are high. The survey data was compared against the SEPA estimates, and found to be similar, suggesting that data is of a reasonable quality. As with Eurostat, SEPA estimates are based on survey data and change in numbers of businesses, and cannot be considered an indicator of decoupling. The survey data will be further analysed, although no reliable conclusions can be drawn on decoupling from only two data points. All interpretation based on this data should refer to the commentary in Section 3.1.

**Figure 8** Commercial arisings Scotland (in tonnes)



**Sources:**

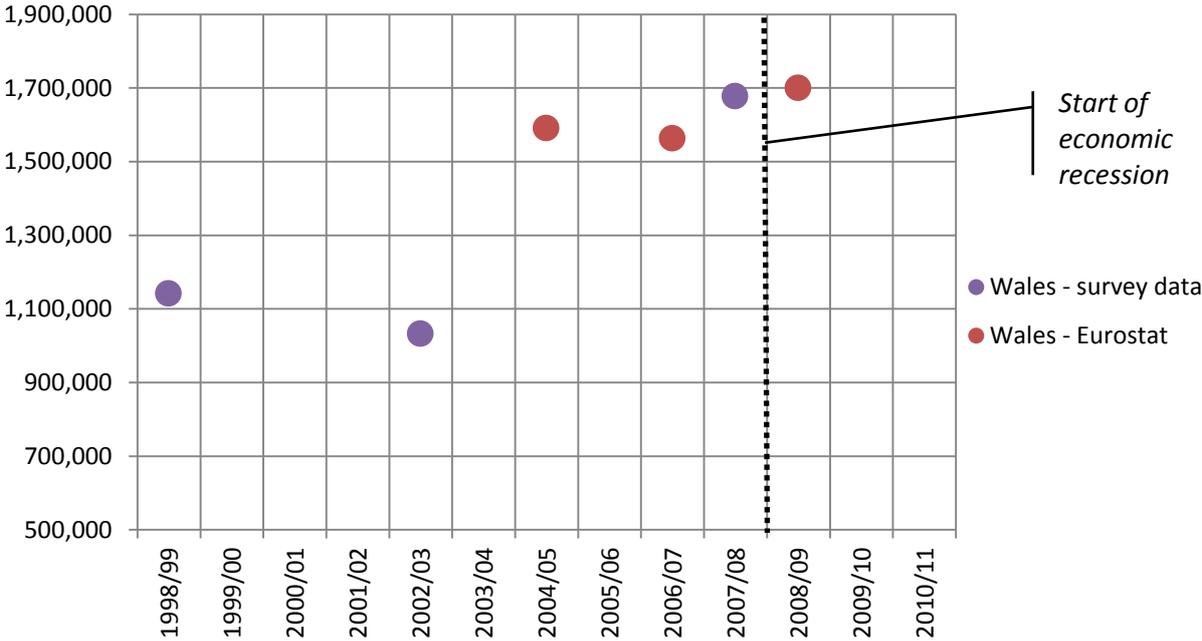
SEPA, 2004; SEPA, 2006; SEPA 2005-10; Defra, 2011b

The survey data suggests a fall in pre-recession arisings. The data overall also suggests a downward trend across the period reviewed.

# Wales

Figure 9 shows commercial waste arisings for Wales. The three surveys in Wales used a consistent methodology. However, some materials were reclassified as non-waste before the last survey (EA Wales, 2009); the tonnages for these materials, although small, have been added back into the 2007/08 data for consistency (noted in Table 2). Confidence intervals for the last survey were good, but are not available for the other sources (EA Wales, 2001; EA Wales, no date). This suggests the survey data should be viewed with a greater degree of caution. The Eurostat data predicts tonnage change according to change in business population, and cannot be considered an indicator of decoupling. We therefore include only survey data for further analysis of decoupling, although all interpretation based on this data should refer to the commentary in Section 3.1.

**Figure 9** Commercial arisings Wales (in tonnes)



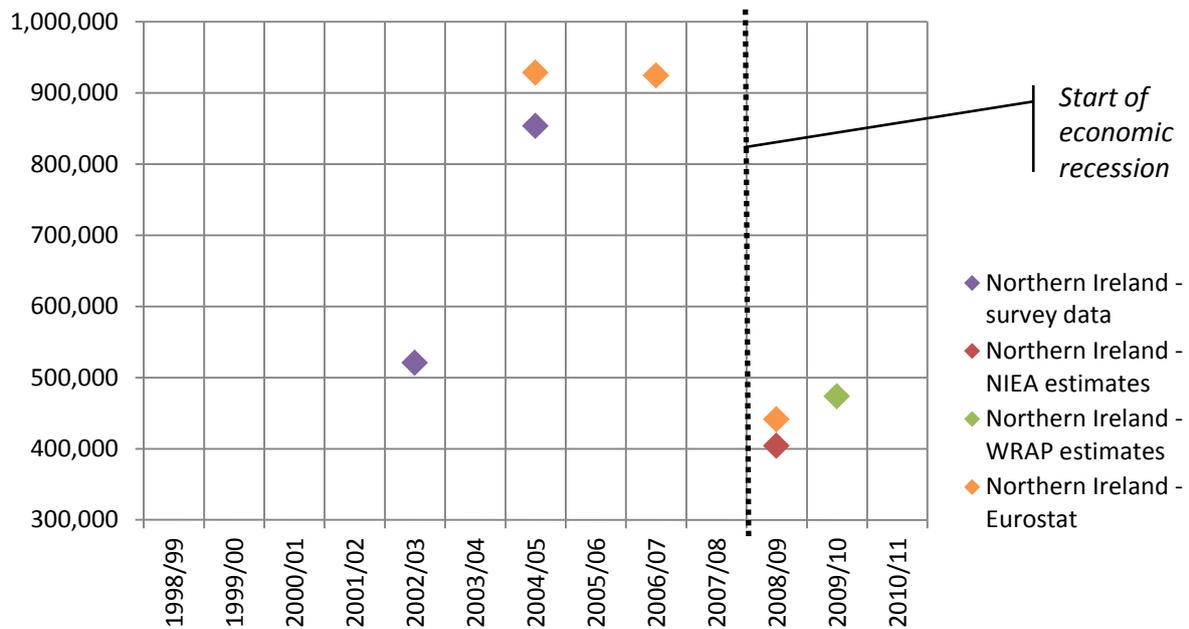
Sources: EA Wales, 2001; EA Wales, no date; EA Wales, 2009; Defra 2011b

There is no clear trend in the survey data. The data overall suggests that arisings increase across the period reviewed.

## Northern Ireland

Figure 10 shows commercial waste arisings for Northern Ireland. There are data from two surveys in Northern Ireland. There are issues with their comparability (discussed in Table 2). Although the pattern of the data could be considered to reflect the strong growth in GVA prior to the economic recession, and the subsequent fall, the extreme fluctuation and methodological issues suggest that the data is not sufficiently reliable for inclusion in analysis. Since the other data in the figure is derived from that data, we have not included Northern Ireland commercial data in the further analysis.

**Figure 10** Commercial arisings Northern Ireland (in tonnes)



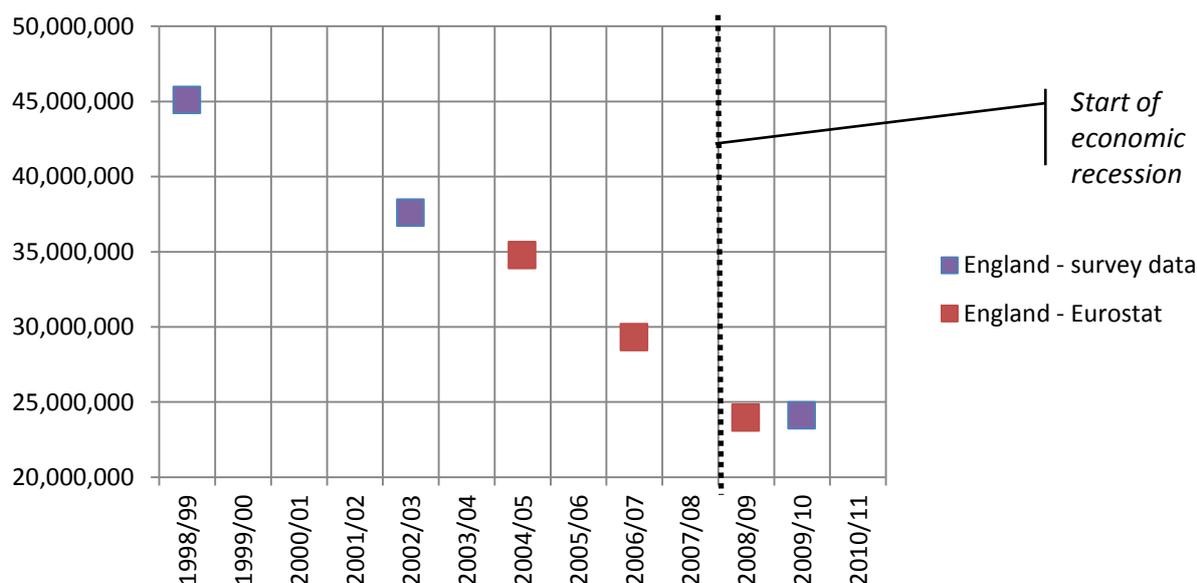
**Sources:**

EHS, 2002; EHS, 2007b; DOENI, 2009a; WRAP, 2001; Defra 2011b

## England

Figure 11 shows industrial waste arisings for England. There are very few data points. The survey data is considered suitable for use in analysis of decoupling, although the possible impact of changed categories and relatively high confidence intervals should be born in mind. The Eurostat data predicts tonnage change according to change in business population, and cannot be considered an indicator of decoupling. We therefore include only survey data for further analysis of decoupling, although all interpretation based on this data should refer to the commentary in Section 3.1.

**Figure 11** Industrial arisings for England (in tonnes)



**Sources:**

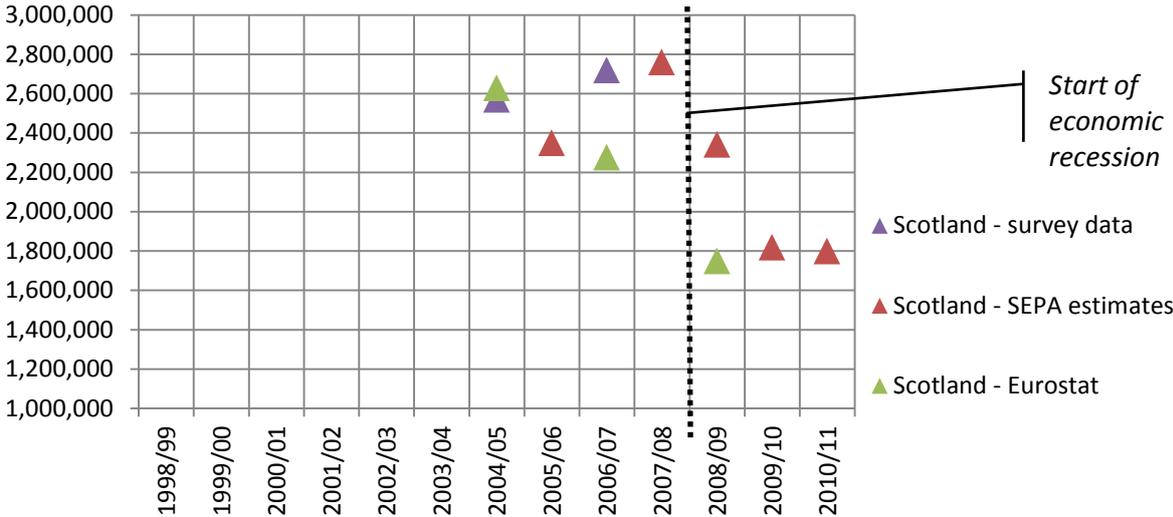
EA, 2005; Defra, 2006; Defra, 2011a; Defra, 2011b

It can be seen that a distinct downward trend is suggested, and the fact that the Eurostat data follows this, suggests that change may be predominantly as a result of shrinkage of the industrial sector. This is because the Eurostat data is based on models derived from the survey data, but extrapolating purely on the basis of business population, so that there is little suggestion of behavioural change where surveys follow the same apparent trend.

## Scotland

Figure 12 shows industrial waste arisings for Scotland. There are more data points for Scotland than England. A consistent methodology was used in the two surveys. Confidence intervals for the survey data are high. The survey data was compared against the SEPA estimates, suggesting that data is of a reasonable quality. As with Eurostat, SEPA estimates are based on survey data and change in business population, and cannot be considered an indicator of decoupling. The survey data will be further analysed, although no reliable conclusions can be drawn on decoupling from only two data points. All interpretation based on this data should refer to the commentary in Section 3.1.

**Figure 12** Industrial arisings for Scotland (in tonnes)



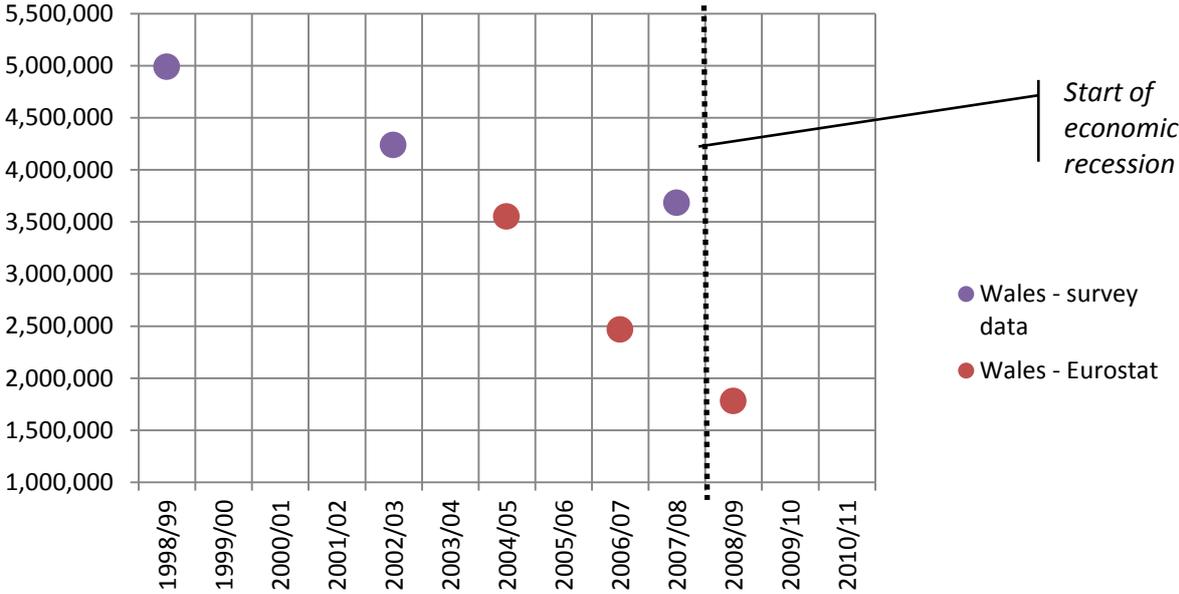
**Sources:**  
 SEPA, 2004; SEPA, 2006; SEPA 2005-10; Defra, 2011b

The surveys suggest an upward trend before the economic recession, and the SEPA data suggests a strong downward trend after its start. It is therefore surprising that the Eurostat data shows a similar trend to SEPA, but starting before the recession. This suggests the two sets of projections were based on different surveys (as stated above, neither are included in subsequent analysis).

### Wales

Figure 13 shows industrial waste arisings for Wales. The three surveys in Wales used a consistent methodology. Non-wastes are included in the 2007/08 data to better compare with survey data from previous years (as noted in Table 2). Confidence intervals for the 2007 survey (EA Wales, 2009) were good, but are not available for the other sources (EA Wales, 2001; EA Wales, no date). This suggests the survey data should be viewed with a greater degree of caution. The Eurostat data excludes non-wastes, and predicts tonnage change according to change in business population; it cannot be considered an indicator of decoupling. We therefore include only survey data for further analysis of decoupling, although all interpretation based on this data should refer to the commentary in Section 3.1.

**Figure 13** Industrial arisings for Wales (in tonnes)



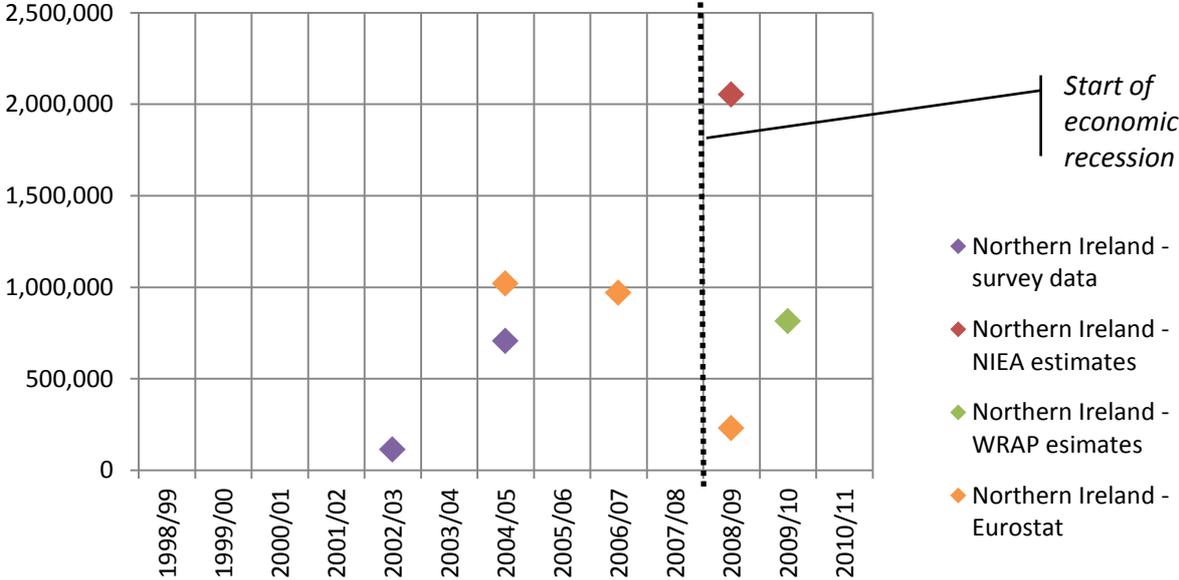
**Sources:**  
 EA Wales, 2001; EA Wales, no date; EA Wales, 2009; Defra 2011b

The surveys suggest a downward trend in arisings. The Eurostat data is not comparable to the survey data due to the exclusion of non-wastes (noted in Table 2).

### Northern Ireland

Figure 14 shows industrial waste arisings for Northern Ireland. The industrial data in Northern Ireland is from the same two surveys as commercial, so it shares the same issues, and is not considered to have sufficient reliability for inclusion in analysis.

**Figure 14** Industrial arisings for Northern Ireland

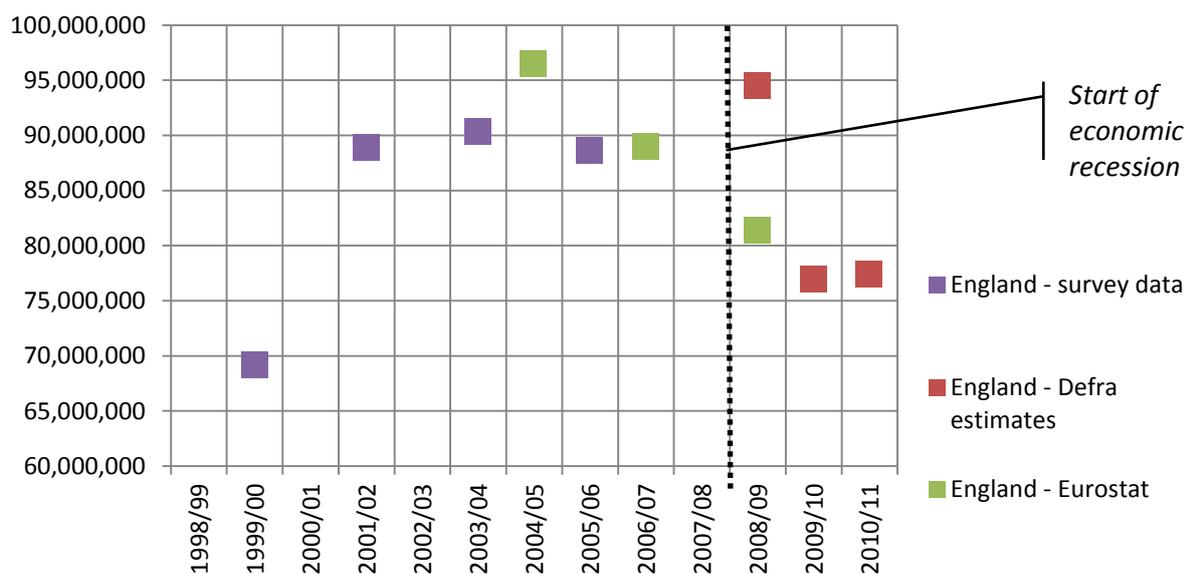


Sources: EHS, 2002; EHS, 2007b; DOENI, 2009a; WRAP, 2001; Defra 2011b

## England

Figure 15 shows C&D waste arisings for England. The surveys can be directly compared with each other, and are therefore included in analysis of decoupling. However it should be noted that the confidence intervals for the data are large, so that the results need to be viewed with more caution. The Eurostat data predicts tonnage change according to change in business population, and cannot be considered an indicator of decoupling. The Defra estimates use a different methodology, and so are not comparable, and are not included in the data for mapping the waste arisings trend. We therefore include only survey data for further analysis of decoupling.

**Figure 15** C&D waste arisings for England (in tonnes)



**Sources:**

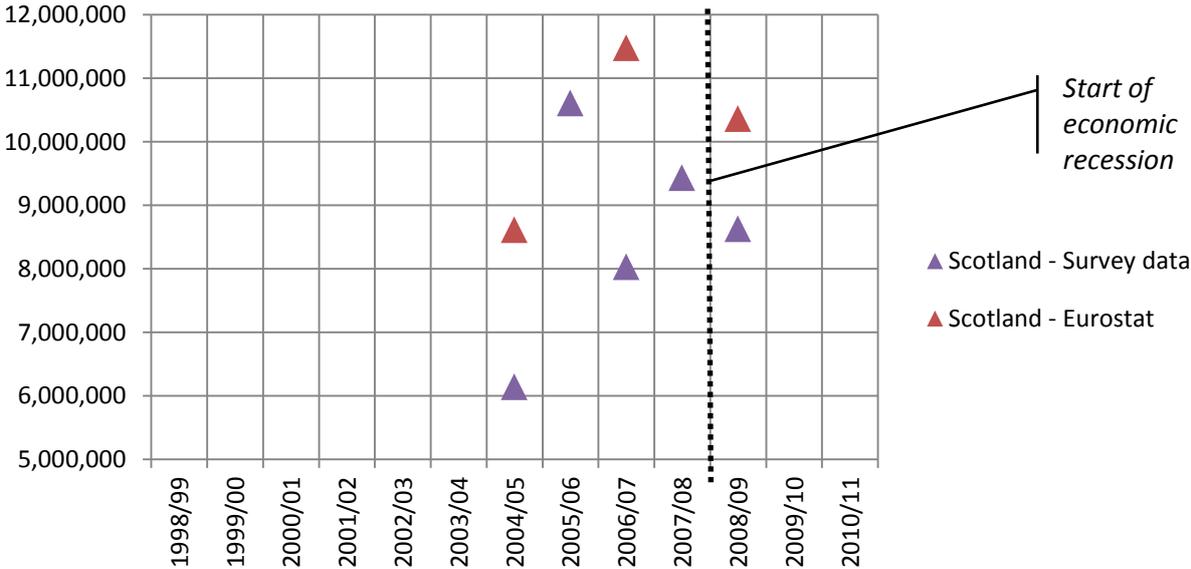
EA, 2001; ODPM, 2002; ODPM, 2004; DCLG, 2007; Defra 2010; Defra 2011b

The survey data suggest a levelling off of arisings from 2001/02. However, there is no survey data for the period following the start of the economic recession. The Eurostat data suggest a fall from 2004/05, before the recession, on the basis of a fall in the business population. All interpretation based on this data should refer to the commentary in Section 3.1.

**Scotland**

Figure 16 shows C&D waste arisings for Scotland. There are more data points, and a consistent methodology was used in the surveys. Although confidence intervals are not given, there should be no significant concerns with this data. However, there is a great deal of variance, as shown in the figure below. Although it is included in further analysis, this does suggest greater caution should be exercised in relation to this data. The Eurostat data predicts tonnage change according to change in business population, and cannot be considered an indicator of decoupling. We therefore include only survey data for further analysis of decoupling, although all interpretation based on this data should refer to the commentary in Section 3.1, as well as the note above.

**Figure 16** C&D waste arisings for Scotland (in tonnes)



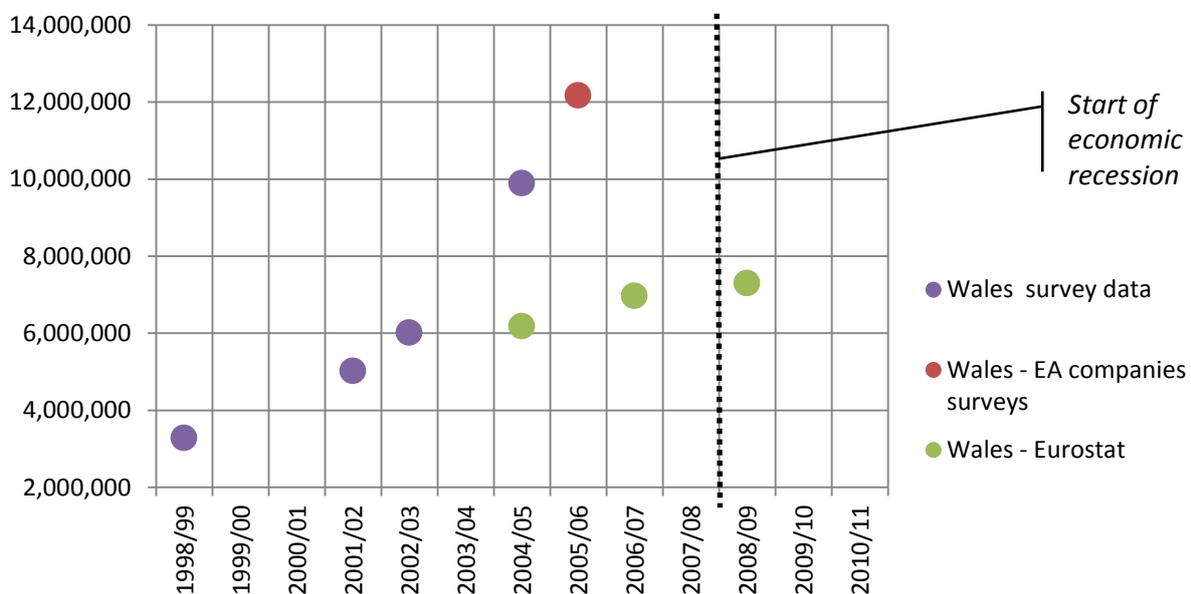
Sources:  
SEPA, 2004-09; Defra, 2011b

There are no clear trends in the data, which suggest either considerable volatility in the sector or weakness in the survey methods.

## Wales

Figure 17 shows C&D waste arisings for Wales. The survey data should be treated as less reliable, and comparisons between the studies should be made with caution as there are some methodology differences as well as the broad confidence intervals which could overlap. The 2004/05 StatsWales data included waste re-used on site, so that this cannot be compared to other surveys (no breakdown of the data available in order to address this difference). It has therefore been excluded from further analysis. The EA company survey data is not comparable with previous studies, and is therefore also not included in the data for analysis. The Eurostat data excludes non-wastes. When non-wastes are taken out from the 2005/06 survey data (EA Wales, 2007), the survey result sits between the 2006 and 2008 Eurostat figures. This suggests that the change in business population is a reasonably accurate way of predicting changes in industrial waste arisings in Wales. However, as the Eurostat data is secondary, it cannot be considered an indicator of decoupling. We therefore include only survey data, excepting the 2004/05 StatsWales and 2005/06 EA data, for further analysis of decoupling, although all interpretation based on this data should refer to the commentary in Section 3.1.

**Figure 17** C&D waste arisings for Wales (in tonnes)



**Sources:**

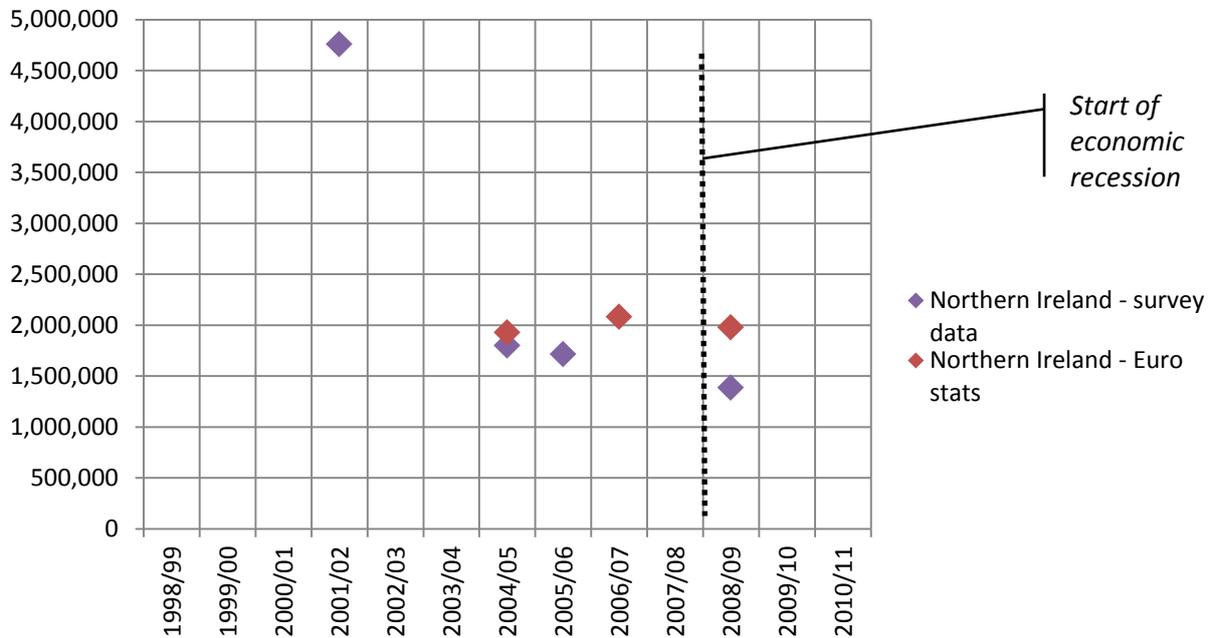
EA, 2001; ODPM, 2002; StatsWales, 2012; EA Wales, 2007; Defra, 2011b

The data suggests a steady trend in increased arisings. There is some suggestion of levelling off around the start of the economic recession; however, this observation is based on the Eurostat data (calculated on the basis of previous waste arisings data and change in business population), so may not be a true reflection. All interpretation based on this data should refer to the commentary in Section 3.1.

## Northern Ireland

Figure 18 shows C&D waste arisings for Northern Ireland. There are considerable differences in methodology between the surveys, so that this data is not suitable for analysis. Since the other data available is derived from that data, we have not included any Northern Ireland C&D waste data in the further analysis.

**Figure 18** C&D waste arisings for Northern Ireland (in tonnes)



**Sources:**

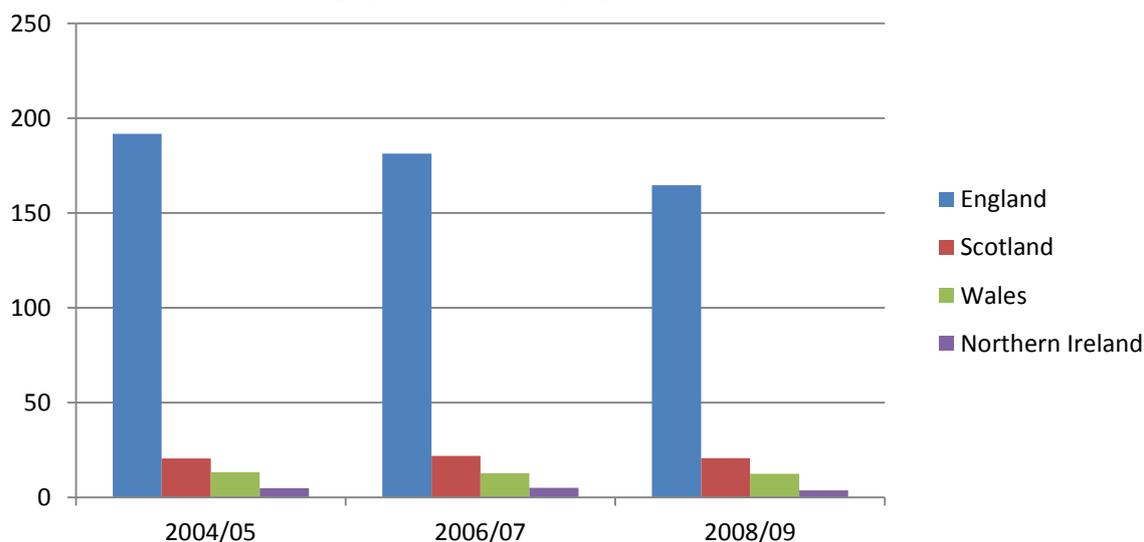
EHS, 2003; EHS 2006b; DOENI, 2009b

### 3.3 Total waste arisings at the UK and UK nations levels

This section gives total waste arisings for the UK nations, composed of the sums of LACW (this includes the Household stream), commercial, industrial and C&D wastes. Due to the lack of data the analysis in this section is limited to three years of figures and the Eurostat data has been used to create these totals (although in some cases other sources have been used to create the variables where there are gaps in the Eurostat data). There Eurostat data will have similar quality issues as the survey data, as it is modelled on that data and change in business population.

In viewing [Figure 19](#) it should be remembered that this figure is based on the data set out in the above sections, so that appropriate levels of caution should be applied. There will also be a small level of double counting of commercial and industrial waste, where the masses of these streams are included within LACW as well as the survey data for each stream. Caution is particularly needed in view of the high contribution to these data from the larger and less reliable sources of commercial, industrial and C&D waste data. These together contribute 80% – 85% to total arisings (see [Figure 21](#)). The contribution of C&D waste is noted below, and is particularly pertinent in Wales, where a different method of calculating such arisings is used. It must also be noted that Eurostat data has been excluded from further analysis, so that this UK data must also be considered unsuitable for further analysis.

**Figure 19** Total waste arisings per UK nation (Mt)

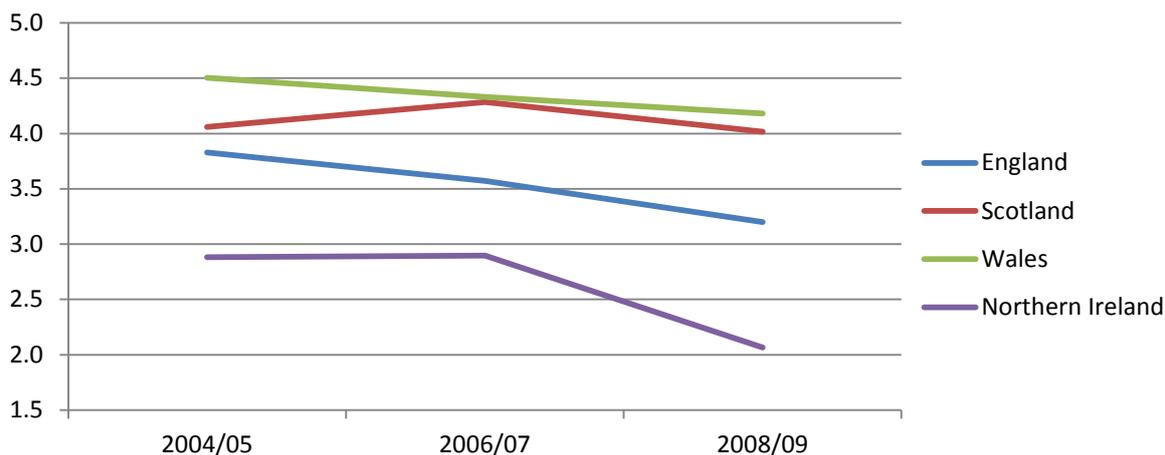


Sources: Sum of sources from [Table 2](#)

It can be seen that that England produces the greatest volume of total waste arisings, as would be expected in consideration of relative populations (see waste arisings per capita below). There have been apparent reductions in total waste arisings for three of the four nations over the years 2004/05 to 2008/09. In England, the data suggests that total arisings decreased between 2004/05 and 2008/09 by approximately 13%, while total waste arisings for Scotland appear to have remained approximately constant during this period.

[Figure 20](#) shows total waste arisings per capita (trends compared using economic indicators are set out in the next chapter). This measure is used to control for the greatly differing sizes of the countries. However, since the larger part of the data is from sources other than LACW (see [Figure 21](#)), which may be more sensitive to the size of the economy than population, this figure should only be considered to be a guide. See also charts against economic indicators in the following chapter.

**Figure 20** Total waste arisings per UK nation (Tonnes per capita)

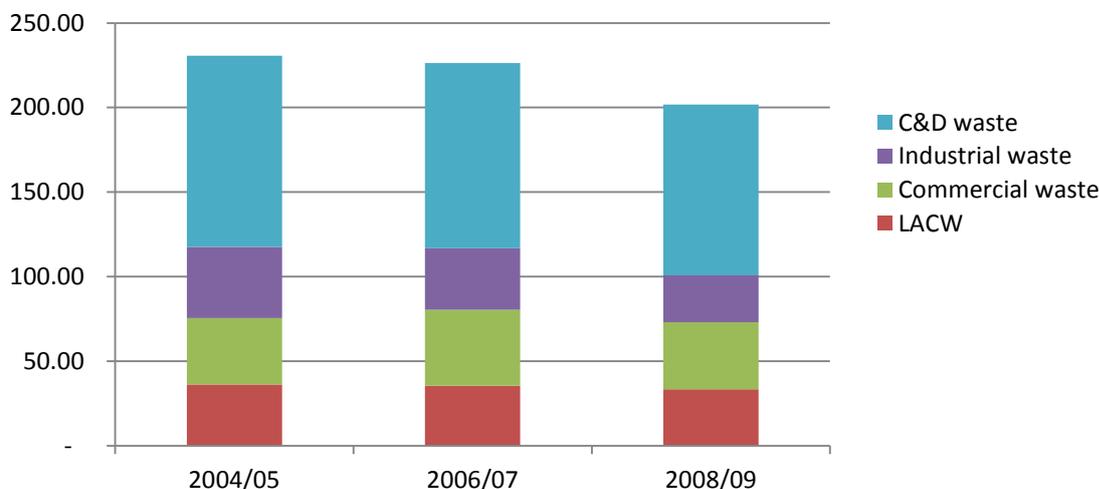


Sources: Sum of sources from Table 2

The figure suggests considerable variation in per capita arisings. However, although the best efforts have been made to compare surveys within countries, as arisings per country is the focus of this research, a great deal more research would be required to understand survey methods between nations. Therefore such apparent differences may well be the result of differing survey methodologies (on which the Eurostat data is based), so that such comparison cannot be considered reliable. The point above regarding the dominance of non-LACW sources, in particular C&D waste, is very relevant to this point.

Figure 21 gives total UK waste by stream. C&D waste is the largest category.

**Figure 21** Total waste UK arisings by stream



Sources: Sum of sources from Table 2

### 3.4 Conclusions

There is suitable primary data for comparison and analysis of the Household and LACW waste streams across all UK nations, although the Household data is considered most appropriate for analysis of waste arisings. However, the issue of changes in definitions of wastes and variance in waste collection across countries and years present some uncertainty in any conclusions drawn from the data, particularly in the case of LACW.

The data indicates that Scotland has, in recent years, produced the highest levels of Household waste and LACW arisings per capita. Part of this difference may stem from the

systems of waste collection and measurement methodology in Scotland. England has been producing the lowest levels of Household waste and LACW arisings per capita. Apart from the case of Scotland's Household waste trend, the trends for both Household waste and LACW are similar between the UK nations. Household waste arisings reach between 500 and 600kg per capita, and LACW reach between just under 500 to 700kg per capita, before falling away; this change in trends occurred prior to the start of the economic recession in all countries.

There is limited primary data available for commercial, industrial, and C&D waste streams in most cases, and there is no system in place for gathering comprehensive data. In many cases the survey data has high confidence intervals, or no confidence intervals provided, and should therefore be viewed with caution. The data can therefore only be used to tentatively suggest national trends, and only reliable primary data, based on consistent methodology, can be used for analysis of decoupling.

Regarding commercial waste, the trends tentatively suggest differences between nations; that there has been an increase in England pre-recession and subsequent fall after the start of the recession, while there has been a fall in Scotland, and an increase in Wales across the period under review. Regarding industrial waste, the trends tentatively suggest similarities between nations; that there has been a decrease across the period under review. Regarding C&D waste, the trends tentatively suggest differences between nations; that there has been an increase then fall in arisings in England pre-recession and subsequent continuation of the fall after the start of the recession, while there has been a sharp increase in Scotland pre-recession followed by a fall at around the time of the recession, and an increase in Wales pre-recession.

All conclusions should be considered in the context of the comments on data quality in section 3.1. Differences in trends, and drivers for these, are considered further in Chapters 4.0 and 5.0.

The level of investigation and commentary on the data sources is limited by the scope of the study; further research to better understand the data sources may provide further clarity. The current proposal for comprehensive data gathering (eDOC scheme) could also help to gather the data required for more robust assessment and analysis of waste arising trends.

## 4.0 Decoupling of waste arisings from economic indicators

This chapter explores the extent of decoupling of waste arisings from economic indicators through a qualitative review of their trends. The waste arisings data selected for this analysis is assessed in Chapter 3.0. Economic indicators used for the analysis include:

- **Gross Value Added (GVA)** – used for assessing national or regional economic performance; it is a measure of economic output and describes the total value of goods and services produced through economic activity (i.e. income generated by economic activity) in any particular period. GVA is similar to Gross Domestic Product<sup>7</sup>.
- **Gross Disposable Household Income (GDHI)** – an alternative measure of income; it measures what is available for households to spend or save once taxes, social contributions, pension contributions and property ownership have been taken into account.
- **Household Expenditure (HE)** – encompasses all domestic outlays (by residents and non-residents) for individual needs, including expenditure on goods and services.

Each waste stream is assessed in turn across all of the nations, which should facilitate a review of the differences and similarities in relationships between waste arisings and the above indicators. Household waste arisings are compared against GDHI, HE and GVA. Commercial, industrial and C&D waste streams are compared against sectoral GVA that represent relevant economic activities in the case of England, Scotland and Wales. Data limitations, as discussed in sections 3.2.4, 3.2.5 and 3.2.6, prevent analysis of decoupling of these streams for Northern Ireland. Sectoral GVA (the sum of selected categories of total GVA) and categories of HE are discussed in Appendix 3. The economic indicators have been deflated to 2010 prices to allow comparison across the period reviewed. To enable comparison of Household waste arisings, per capita figures are used.

During the analysis, different terms are used to describe the type of decoupling that appears to be occurring, as discussed in section 1.2. It is also important to note that, due to the recent economic recession and the consequent stagnant or shrinking economy, only relative decoupling can occur if waste generation has decreased at a rate greater than that of the economic activity.

The findings of the chapter are supplemented by the results of the quantitative analysis of drivers of Household waste arisings (section 5.3), which uses regression analysis to test the effect of certain indicators (selected as proxies for potential drivers of waste arisings), including GVA, HE and GDHI.

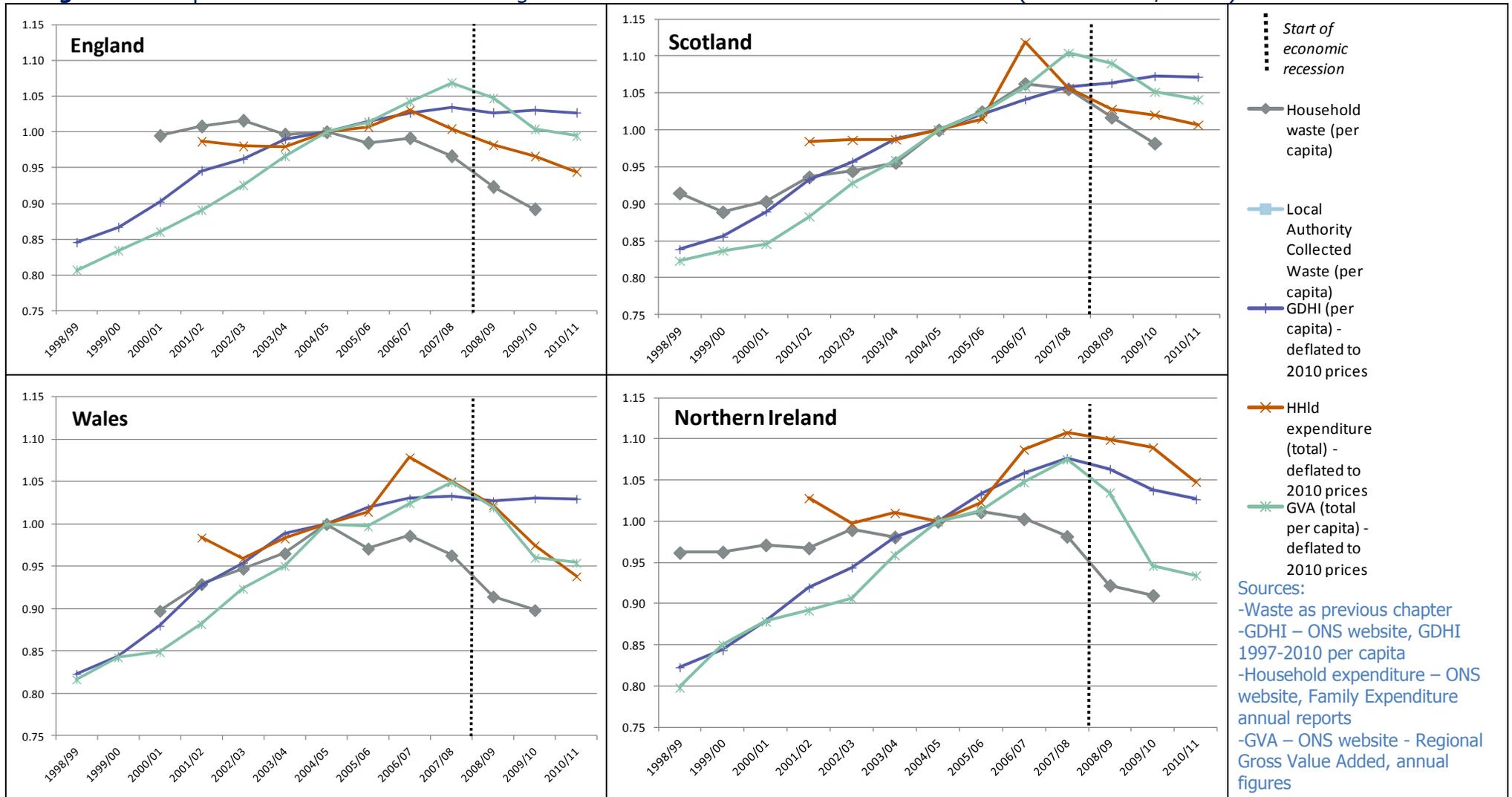
### 4.1 Household waste

Figure 22 shows trends for Household waste arisings plotted alongside GDHI, GVA and HE, indexed to 2004/05, to explore the relationships between waste arisings and economic indicators.

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<sup>7</sup>  $GVA + \text{taxes on products} - \text{subsidies on products} = GDP$

**Figure 22** Comparison of Household waste arisings and economic indicator trends across UK nations (indexed 2004/05 = 1)



### 4.1.1 Assessment of household decoupling at national level

Although the definition changes across the years and in the different nations (see Chapter 3.0) have led to slight variation in the scope of the Household waste stream, it is primary data and considered suitable for analysis of decoupling.

#### England

It can be seen from [Figure 22](#) that GHDI rose or remained stable throughout the period reviewed. However, Household waste started to fall from 2004/05, while HE started to fall immediately before the start of the economic recession in 2006/07, and GVA fell just after it. There is absolute decoupling of Household waste arisings from GDHI, and a short period of decoupling from 2004/05 to 2005/06; however, from 2005/06 waste rose and fell in line with HE, suggesting a strong link, or coupling, between HE and Household waste arisings, as would be expected. It is interesting that GDHI, although no longer increasing at the point of the economic recession, simply flattens off. This suggests that the perception of the 2007 credit crunch precipitated a loss of consumer confidence, with HE falling while income was yet unaffected, and that Household waste arisings are not coupled to GDHI at a time of low consumer confidence (although they may well be at other more positive times).

#### Scotland

The pattern in [Figure 22](#) is quite similar to that seen for England, although Household waste started to fall later, just before the start of the economic recession, alongside HE, while GVA fell after the start of the economic recession and GDHI flattened off. However, although there is absolute decoupling of Household waste from GDHI, there is no evidence of absolute decoupling from HE. This supports the suggestion that Household arisings are strongly coupled to HE. As for England, a fall in consumer confidence is likely to have created the suggestion of decoupling of GDHI from waste arisings.

#### Wales

As shown in [Figure 22](#), Wales has similar patterns to England. GHDI continued to rise throughout the period reviewed, whereas waste started to fall from 2004/05 and HE from 2006/07. This suggests absolute decoupling of waste from GDHI is occurring. HE declined approximately as fast as waste, apart from a short period of absolute decoupling from 2004/05 to 2005/06. This suggests coupling. Again, this suggests that whilst peoples' incomes have been stable over time, they have been spending less of their money. Whilst there is coupling in Wales between HE and waste, there is relative decoupling in England and Scotland. There are a number of possible reasons for this (e.g. a greater proportion of spend in Wales may be on material items which then become waste), and possible drivers will be assessed in chapter 5.

#### Northern Ireland

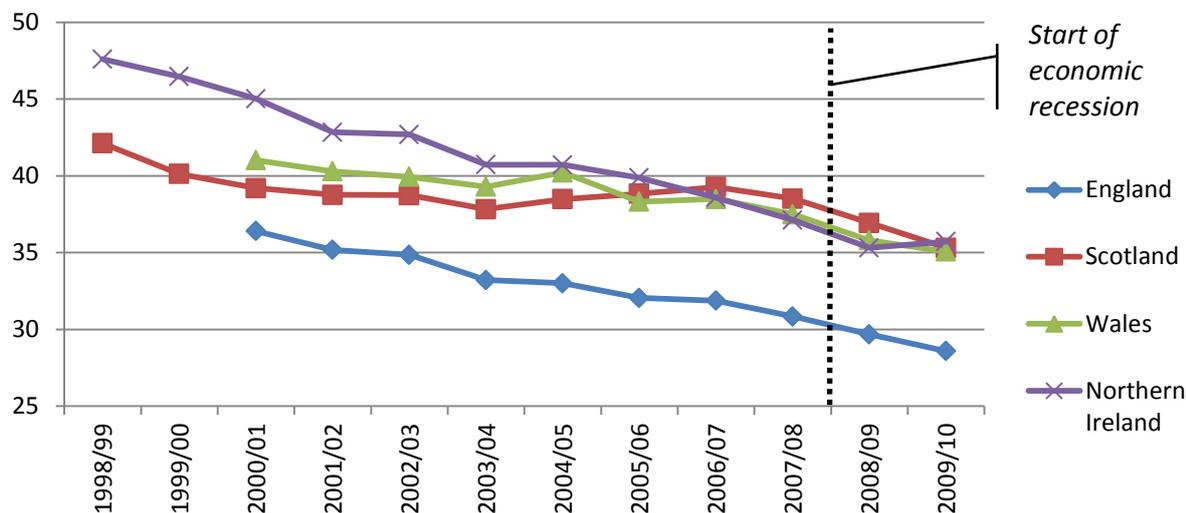
[Figure 22](#) illustrates that the relatively complex trends for waste and indicators for Northern Ireland. GHDI rose through most of the period reviewed, until shortly after the economic recession. HE followed a similar pattern. The trends suggest periods of absolute decoupling of waste from GDHI and HE from 2005/06 to 2007/08. From 2007/08, the trends of both HE and GDHI fall with waste, hence appear to be coupled.

#### 4.1.2 Comparison of household waste arisings per unit GDHI and HE

Section 4.1.1 has shown that Household waste across all UK nations has experienced some level of decoupling from GDHI and HE across the period reviewed, but that it has reverted to a coupled state in some cases.

Figure 23 shows the trends of Household waste per unit GDHI across the period reviewed.

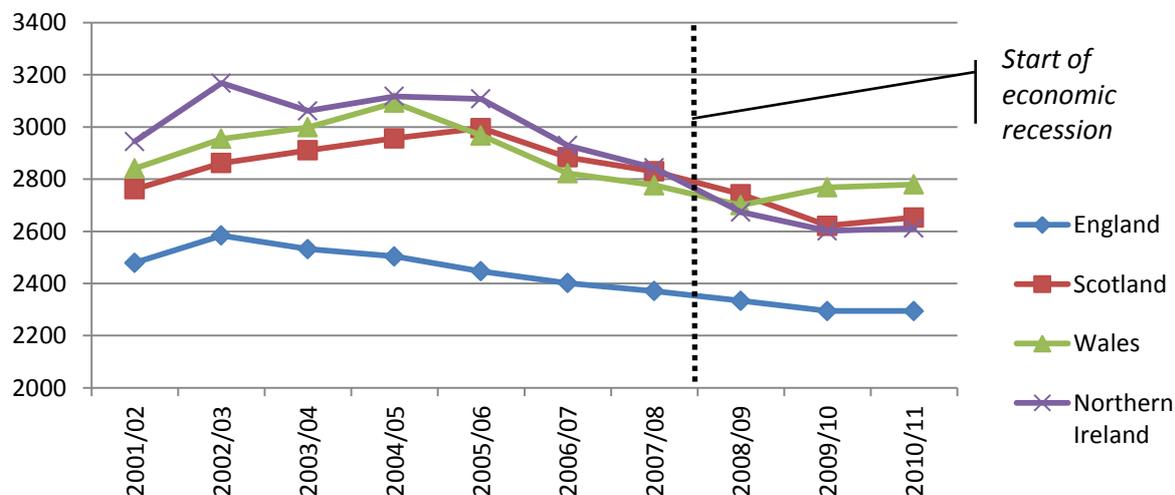
**Figure 23** Household waste intensity per unit GDHI (g / GDHI in 2010 £ / capita)



Sources: Waste as per Figure 24  
GDHI – ONS website, GDHI 1997-2010 per capita

England has the lowest levels of Household waste arisings per unit GDHI. The trends or relative decoupling are similar and indicate a long-term fall in waste arisings per unit GDHI for all UK nations. The high Household arisings per capita for Scotland from 2004/05 shown in Figure 5 may be due to economic drivers, as Figure 23 shows it has similar levels of waste per unit GDHI. The recent reversal in the trend for Northern Ireland suggests a change to a more coupled relationship. Figure 24 shows the trends of Household waste per unit HE across the period reviewed.

**Figure 24** Household waste intensity per unit HE (g / HE in 2010 £ / Household / week)



Sources: Waste as previous chapter  
GDHI – ONS website, GDHI 1997-2010 per capita

England has the lowest levels of Household waste arisings per unit HE. Figure 24 again shows that the high Household arisings per capita in Scotland from 2004/05 (shown in Figure 5) may be due to economic drivers, as it has similar levels of waste per unit HE. The trends are similar and indicate reductions in arisings per unit HE across the UK nations. Since the start of the economic recession the downward trend has slowed, and in Scotland, Wales and Northern Ireland has reversed, suggesting a more coupled relationship.

#### 4.1.3 Summary

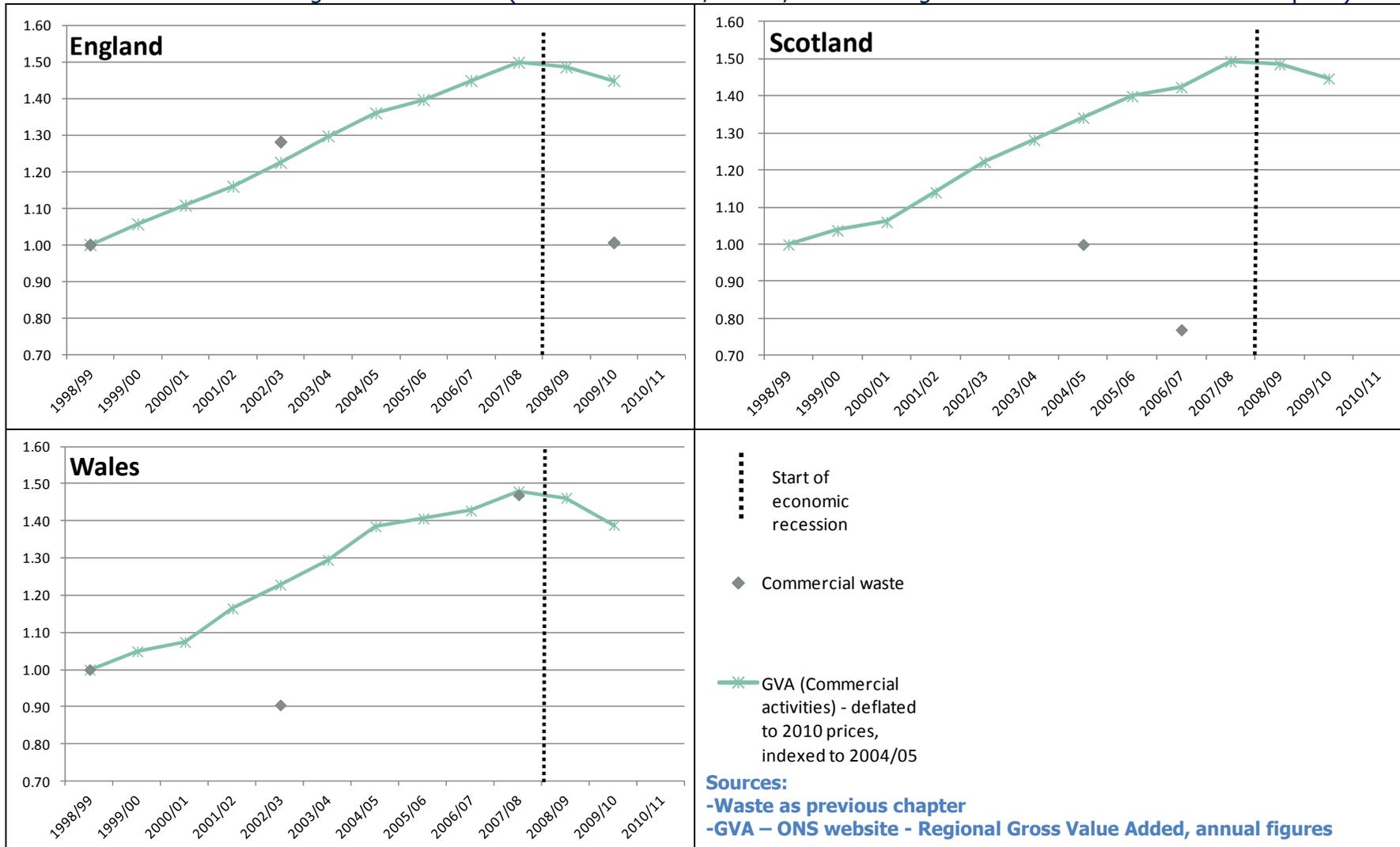
There are similarities in the trends of Household waste, GDHI, HE and GVA between the UK nations, all showing periods of absolute decoupling of waste from GDHI. While some demonstrate short periods of absolute decoupling of waste from HE, overall it appears that HE and waste tend to be coupled. As the data are in constant prices (i.e. deflated to 2010 £) this indicates that, whilst households' incomes have been stable over time in most nations, they have been spending less of this money; HE may therefore be a better proxy indicator to represent the economic driver of waste arisings than GDHI, at least in the short term.

There are also similarities in relationships between Household waste arisings and economic indicators across the nations. Most show a fall in waste per unit of the indicator, including during the period prior to the economic recession when economic indicators rose, confirming decoupling. It is interesting to note that the levels of Household waste arisings per unit economic indicator are significantly lower in England than the rest of the UK nations. In addition, the high Household waste per capita for Scotland discussed in sections 3.2.1 and 3.4 are contrasted by the very similar levels of Household waste per unit GDHI and HE in Scotland, Wales and Northern Ireland. The recent increases in waste arisings per unit indicator may be due to the change in the economy; reductions in waste have continued, but the rate of this reduction is not as rapid as that of the economic indicators.

## 4.2 Commercial waste

Figure 25 shows indexed trends for commercial waste arisings and GVA for commercial activities, to explore the relationships between waste arisings and the relevant categories of sectoral GVA (see Appendix 3).

**Figure 25** Commercial waste arisings and GVA trends (GVA indexed 1998/99 = 1; waste arisings indexed to earliest available data point)



#### 4.2.1 Assessment of commercial decoupling at national level

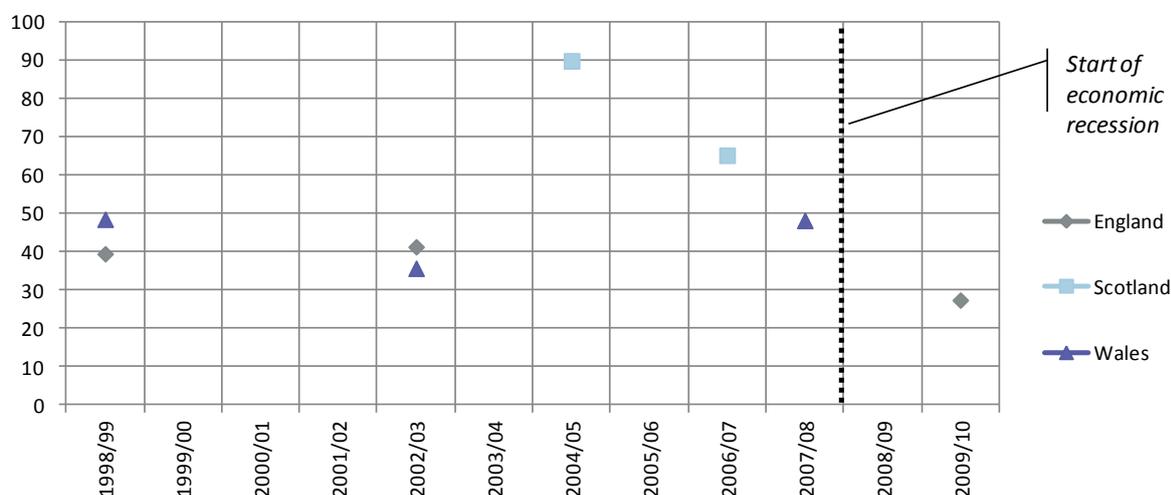
In all nations, commercial GVA rose until the start of the economic recession. There appear to be periods of decoupling in all England, Wales and Scotland. In particular, there appears to be a significant reduction in arisings in England between 2002/03 and 2009/10. However, as the economic recession occurred during this period, it is not possible to comment on whether the decoupling is relative or absolute.

Whilst there are common trends in GVA across all nations, additional primary data would be required to comment further on waste trends for England, Wales and Scotland. As outlined in Chapter 3.0, it is therefore not possible to derive any reliable conclusions on decoupling.

#### 4.2.2 Comparison of commercial waste arisings per unit sectoral GVA

Figure 26 shows the trends for commercial waste arisings per unit commercial GVA.

**Figure 26** Commercial waste intensity per unit commercial economic activity (tonnes / commercial GVA in £ million)



Sources: Waste as previous chapter  
GVA – ONS website - Regional Gross Value Added, annual figures.

Data for England and Wales indicates relatively stable levels of waste generated per unit GVA. Scotland has the highest levels, although this appears to be falling to a level similar to that of the other nations. Apart from indicating relative consistency in arisings per unit sectoral GVA across the period reviewed for England and Wales, data limitations and quality concerns outlined in Chapter 3.0 prevent any firm conclusions from being drawn.

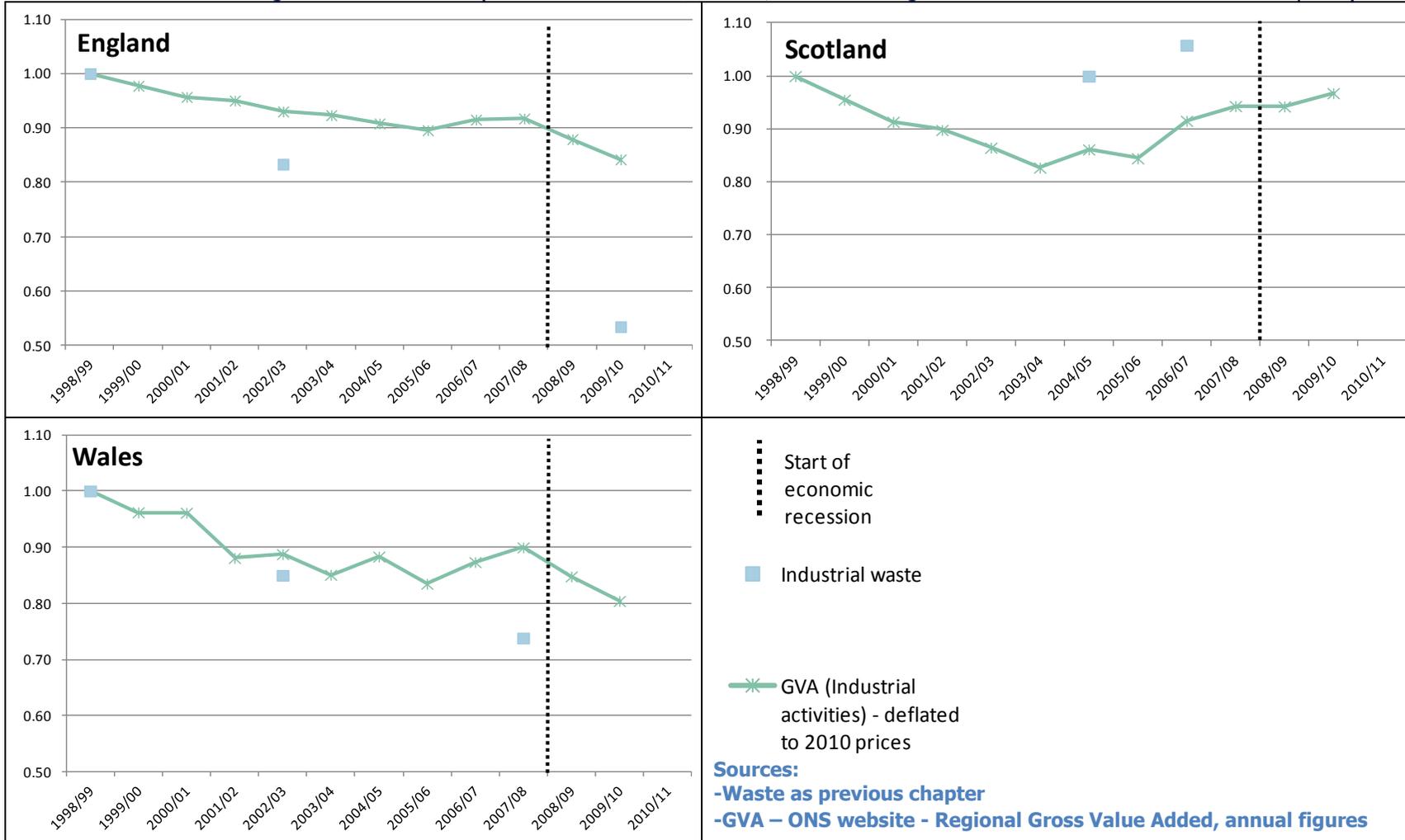
#### 4.2.3 Summary

There are similarities in trends of commercial GVA across the nations. These show a significant rise in GVA prior to the recession, and a subsequent reduction following the recession. However, due to limited data of waste arisings, it is not possible to derive any clear trends on decoupling. More regular primary data would be required to draw such conclusions.

### 4.3 Industrial waste

Figure 27 shows indexed trends for industrial waste arisings and GVA for industrial activities, to explore the relationships between waste arisings and the relevant categories of sectoral GVA (see Appendix 3).

**Figure 27** Industrial waste arisings and GVA trends (GVA indexed 1998/99 = 1; waste arisings indexed to earliest available data point)



### 4.3.1 Assessment of industrial decoupling at national level

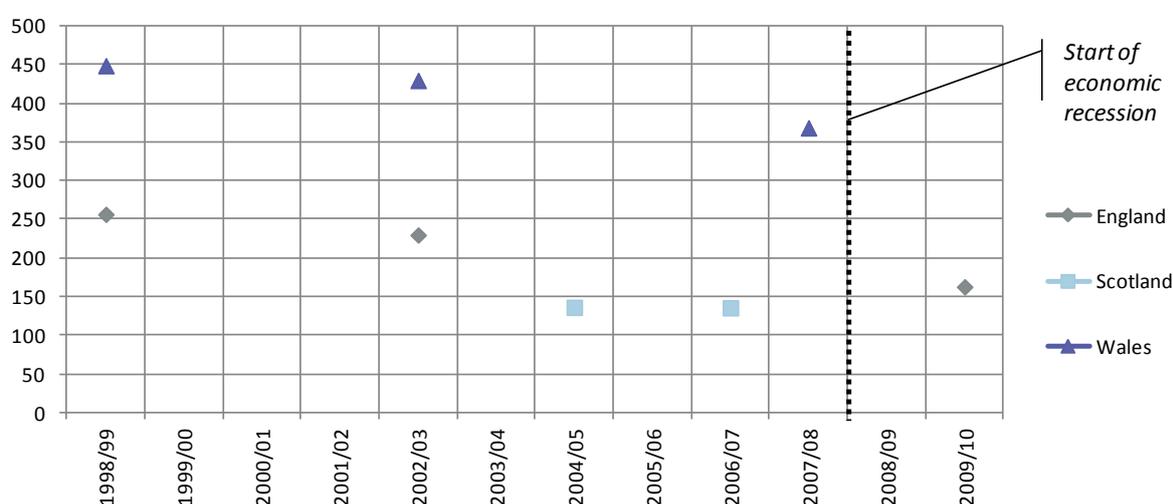
In all nations, industrial GVA fell from 1998/99 to 2005/06, prior to the economic recession, at which time it began to rise. In England and Wales this rise halted shortly after the recession, whereas it continued to rise in Scotland. There appear to be periods of decoupling in all England and Wales, whilst for Scotland the limited data suggests that waste and industrial GVA are coupled.

Whilst there are common trends in industrial GVA across all nations, additional primary data would be required to comment further on waste trends for England, Wales and Scotland. As outlined in Chapter 3.0, it is therefore not possible to derive any reliable conclusions on decoupling.

### 4.3.2 Comparison of industrial waste arisings per unit sectoral GVA

Figure 28 shows the trends for industrial waste arisings per unit industrial GVA.

**Figure 28** Industrial waste intensity per unit industrial economic activity (tonnes / industrial GVA in £ million)



Sources: Waste as previous chapter  
GVA – ONS website - Regional Gross Value Added, annual figures.

In England and Wales, decoupling is suggested, with reductions in waste per unit sectoral GVA across the period reviewed. While waste per unit sectoral GVA figures are relatively similar in England and Scotland, they appear to be significantly higher for Wales across the period. However, this may well be the result of differing survey methods, as well as other data limitations and quality concerns outlined in Chapter 3.0, which prevent any reliable conclusions from being drawn.

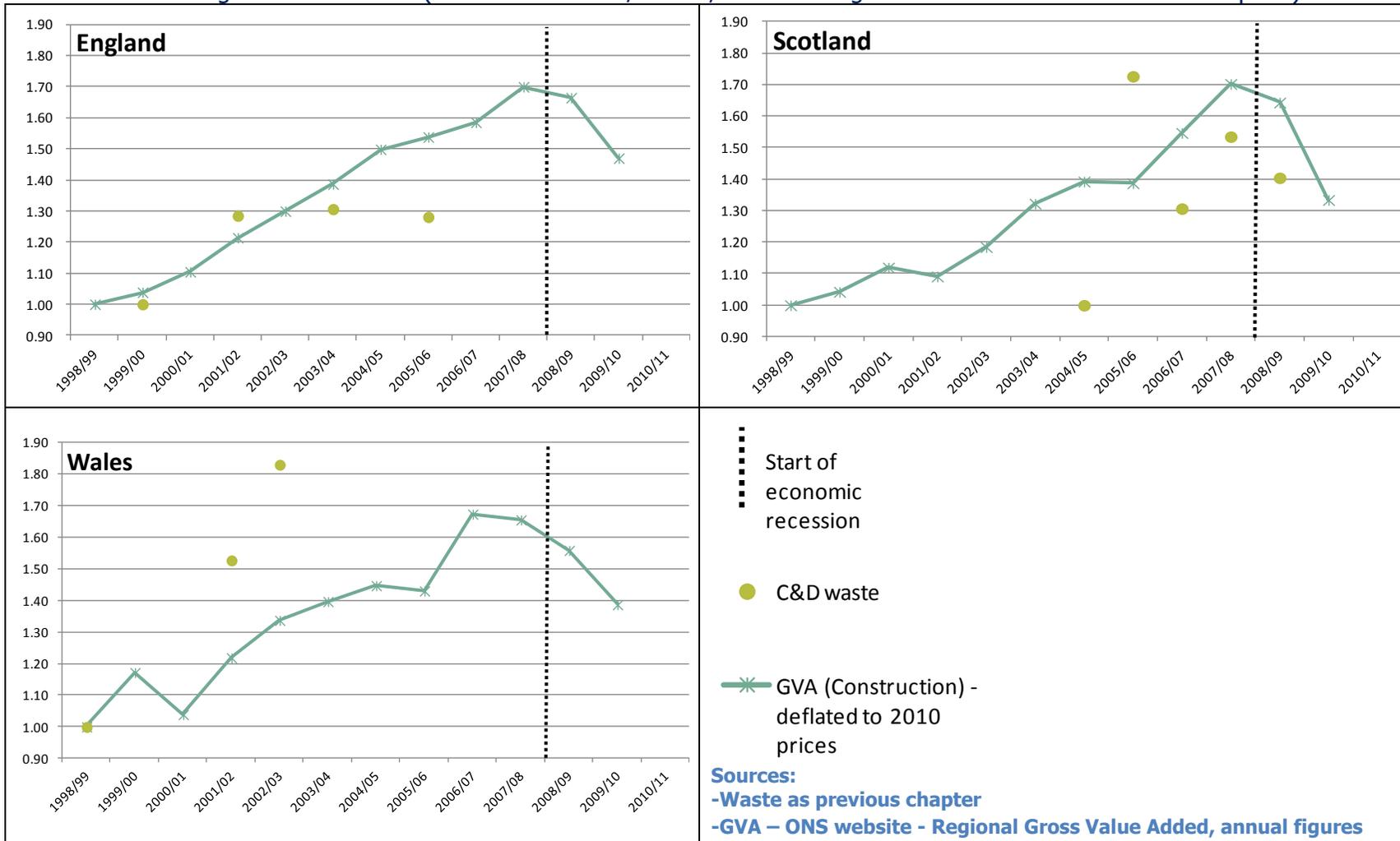
### 4.3.3 Summary

There are similarities in trends of industrial GVA, and in the relationships between industrial waste arisings and industrial GVA, in England and Wales. These trends show greater falls in waste arisings than industrial GVA over the period, indicating decoupling. Additional primary data would be required to comment further on waste trends for England and Wales. Although the data for Scotland suggests coupling, due to the limited number of data points it is not possible to derive any firm conclusions.

#### 4.4 Construction and demolition waste

Figure 29 shows indexed trends for C&D waste arisings and GVA for construction activities, to explore the relationships between arisings and the relevant categories of sectoral GVA (see Appendix 3).

**Figure 29** C&D waste arisings and GVA trends (GVA indexed 1998/99 = 1; waste arisings indexed to earliest available data point)



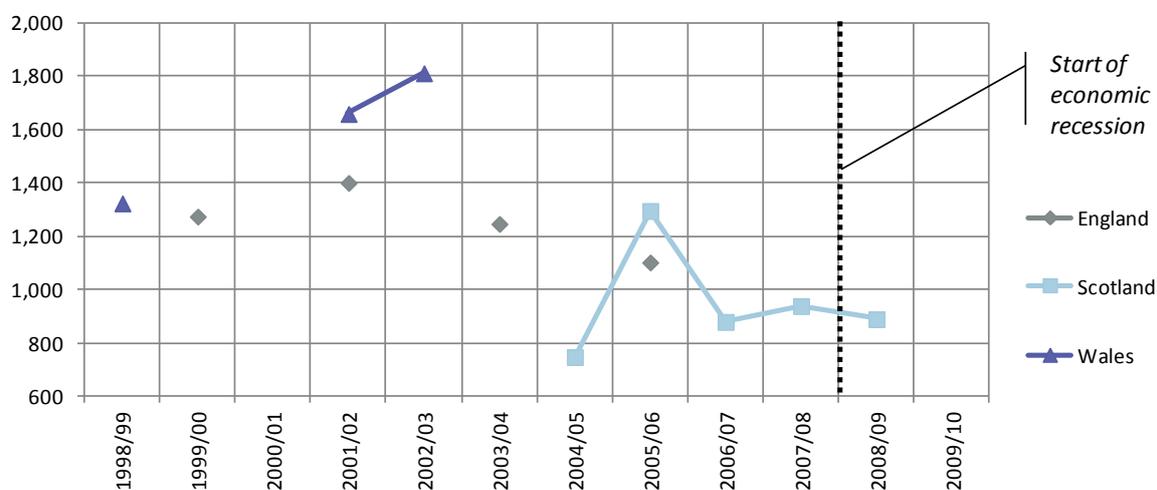
#### 4.4.1 Assessment of construction and demolition decoupling at national level

Construction GVA shows similar trends across all nations, rising pre-recession before significant falls at around the time of the start of the recession. However, waste shows no common trend across England, Wales and Scotland. Furthermore, there are no clear trends in the relationship between waste and GVA, with periods where waste appears decoupled, coupled and negatively coupled (i.e. it grows at a rate exceeding GVA growth). Due to small number of data points, and quality concerns outlined in Chapter 3.0, no firm conclusions on decoupling can be drawn.

#### 4.4.2 Comparison of construction and demolition waste arisings per unit sectoral GVA

Figure 30 shows the trends for C&D waste arisings per unit construction GVA.

**Figure 30** C&D waste intensity per unit construction economic activity (tonnes / construction GVA in £ million)



Sources: Waste as previous chapter  
GVA – ONS website - Regional Gross Value Added, annual figures.

There is significant variation in waste per unit sectoral GVA across the period reviewed. The trends are not conclusive, although levels in England and Scotland appear to have converged somewhat in recent years. The level for Wales is higher due to the inclusion of items that may not be classified as waste being included in survey data (and which cannot be separated from the survey). Data limitations and quality concerns outlined in Chapter 3.0 prevent any firm conclusions from being drawn.

#### 4.4.3 Summary

There are similarities in trends of construction GVA across the nations. These show a significant rise in GVA prior to the recession and sharp falls around the time of the start of the recession. There are no clear trends in the relationship between waste and GVA, with periods where waste appears decoupled, coupled and negatively coupled. Therefore no conclusions can be drawn. .

## 4.5 Conclusions

### 4.5.1 Household waste

There appears to have been short periods of absolute decoupling of Household waste generation from the economic indicators prior to the economic recession across all UK nations, particularly in Northern Ireland, and relative decoupling across much of the period reviewed. This is confirmed by the results of the quantitative analysis of drivers of Household waste arisings (section 5.3).

HE appears to be a better proxy indicator to represent the economic driver of waste arisings, as falls in waste are closely linked with HE. Regarding the instances where “re-coupling” appears to have occurred, more data points are needed to confirm whether there has been a real change in the underlying relationship between waste and the economic indicators.

It is interesting to note that England has lower waste intensity levels (e.g. waste per unit HE) compared to the other UK nations. In addition, Scotland’s relatively high Household waste per capita can be recognised in its relatively high waste intensity. Wales and Northern Ireland seem to have similar high levels of waste intensity as Scotland. The results of the quantitative analysis of drivers of Household waste arisings (section 5.3) confirms that England has the lowest per capita Household waste while the other UK nations all have higher levels, and the differences between nations are statistically significant.

The decoupling trends are similar in all nations. Household waste started to decrease before the economic recession, signifying that decoupling was already occurring. The significant lower waste intensity level of England, compared to the other UK nations, could indicate that the other nations are able to decouple their waste arisings further.

### 4.5.2 Commercial waste

A decoupling relationship between commercial waste arisings and GVA is not clear. Data limitations and quality concerns prevent any firm conclusions from being drawn; more regular primary data is needed to clarify trends and to confirm any conclusions.

### 4.5.3 Industrial waste

There are similarities in trends of industrial GVA, and in the relationships between industrial waste arisings and industrial GVA, in England and Wales. As shown in [Figure 28](#), these trends show greater falls in waste arisings than industrial GVA over the period, indicating decoupling. Additional primary data would be required to comment further on waste trends for England and Wales. Although the data for Scotland suggests coupling, due to the limited number of data points it is not possible to derive any firm conclusions.

### 4.5.4 Construction and demolition waste

There are no clear trends in the relationship between waste and GVA, with periods where waste appears decoupled, coupled and negatively coupled. As shown in [Figure 30](#), the levels of waste arisings per unit GVA trends are highly variable. Data limitations and quality concerns prevent any firm conclusions from being drawn.

## 5.0 Macro-level assessment of the drivers of waste arisings

This chapter presents the assessment, both quantitative and qualitative, of drivers of waste arisings, to better understand what may be influencing the observed differences in waste arisings trends and decoupling across the UK nations.

As discussed in Chapter 4.0, data limitations and quality concerns prevent any firm conclusions on decoupling from being drawn for commercial, industrial and C&D waste streams. However, there have been periods of absolute decoupling of Household waste from GDHI or HE in all UK nations and England has produced the lowest per capita, and per economic indicator, Household waste over the period.

Quantitative analysis can be used to assess the validity of the tentative findings of the analysis of decoupling in Chapter 4.0, as well as an understanding of the relative strength of the effect of drivers on the arisings. Availability of relatively high number of primary data points for Household waste arisings make it possible to make a quantitative analysis using regression analysis. However, there is insufficient primary data to carry out quantitative analysis for commercial, industrial and C&D waste streams.

### 5.1 Literature review on drivers of waste arisings

The literature was searched for evidence of factors that have significant effect on waste arisings (either increasing or acting to reduce arisings). Drivers of all waste streams were considered. The search focused on waste and resource efficiency policy studies and the review included evidence provided by stakeholders.

Many of the drivers described in the literature, derived from quantified macro-economic modelling, are the results of analysis of Household or municipal waste. There appears to be relatively limited analysis of the drivers of commercial and industrial or construction and demolition waste; this analysis is qualitative, based on expert insight or review of case studies. In addition, the literature covers a variety of scopes and definitions for waste streams that do not necessarily match those used in this study.

The literature has however identified numerous factors that influence waste generation:

- There seems to be a strong relationship between increasing population, affluence, consumption and increased economic activity and increasing waste arisings (AEA, 2006; BIO Intelligence Service, 2011a).
- The amount of waste generated depends on individual behaviour and practices, which seem to be correlated with age, gender, education and values (Brook Lyndhurst, 2009).
- Unemployment and household size are negatively correlated with waste arisings per person, i.e. unemployed people and larger households generate less waste per person (Eunomia, 2012)<sup>8</sup>.
- High population density and urbanisation also seem to result in higher levels of waste generation (EEA, 2009), although this may be depend on the availability of reuse and other waste collection systems (recycling programmes seem to have an insignificant effect though).
- Some studies show that waste management costs, e.g. the Landfill Tax, can reduce waste arisings to a certain extent (van den Bergh, 2008), however there is also evidence to suggest that EU policy efforts have not provided any “backward incentive” to stimulate waste prevention (Mazzanti and Zoboli, 2009).

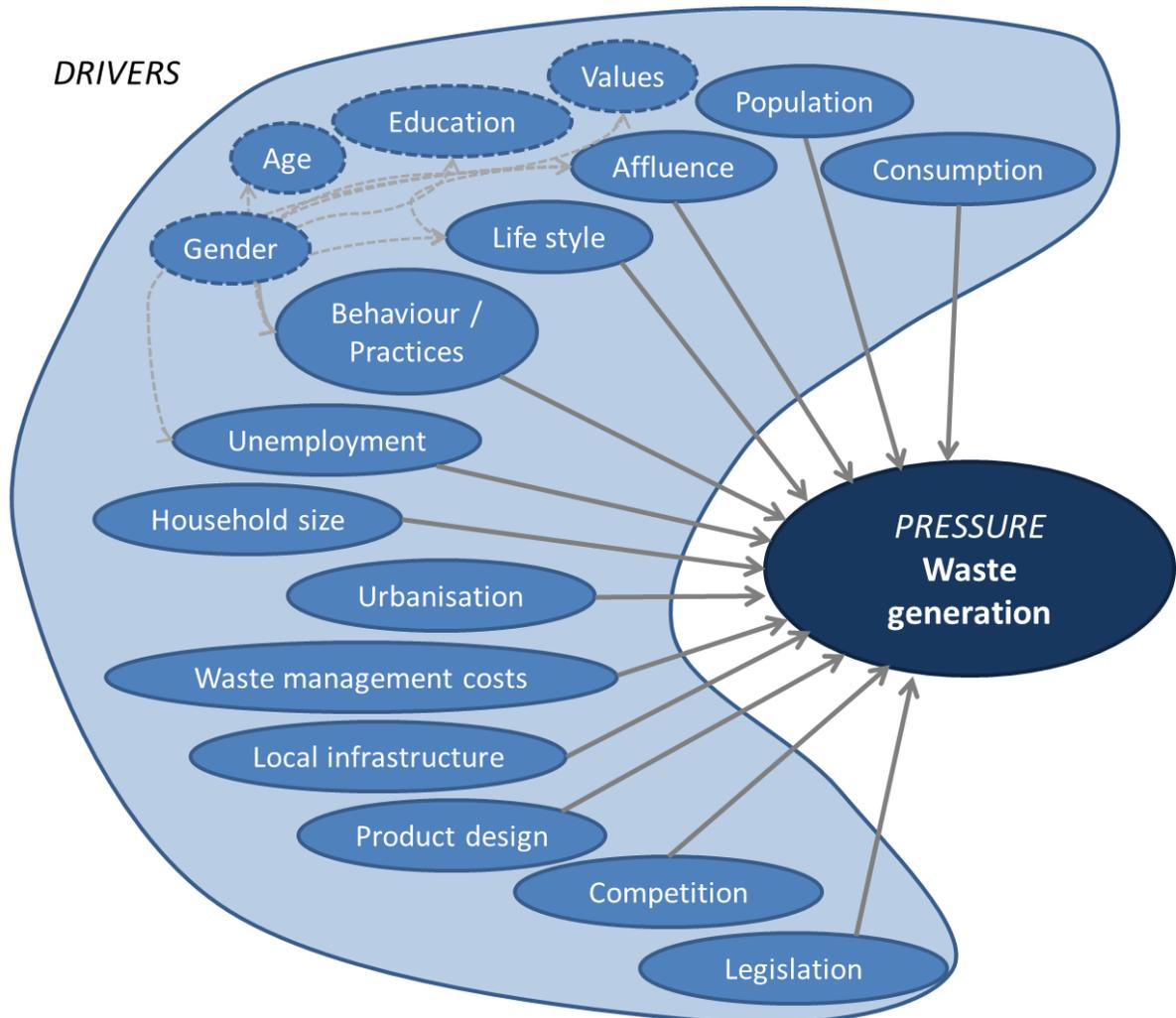
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<sup>8</sup> However, as discussed in Table 3, it was seen that unemployment is not necessary directly coupled to waste arisings; unemployment could however be a driver for household expenditure.

- For businesses, drivers of waste prevention may also be legislation (e.g. the Landfill Tax) and competition, however these drivers are not well understood (Oakdene Hollins, 2011).
- It is also generally believed that the design of products contribute to waste arisings. Products that are cheap, disposable or with short life times and not repairable limit the potential for reuse and encourage greater levels of consumption.

Figure 31 provides a conceptual view of these drivers, within the context of the DPSIR model (see section 1.2 and Figure 4). There may be other interactions between the drivers that are not expressed in the figure, such as affluence driving consumption.

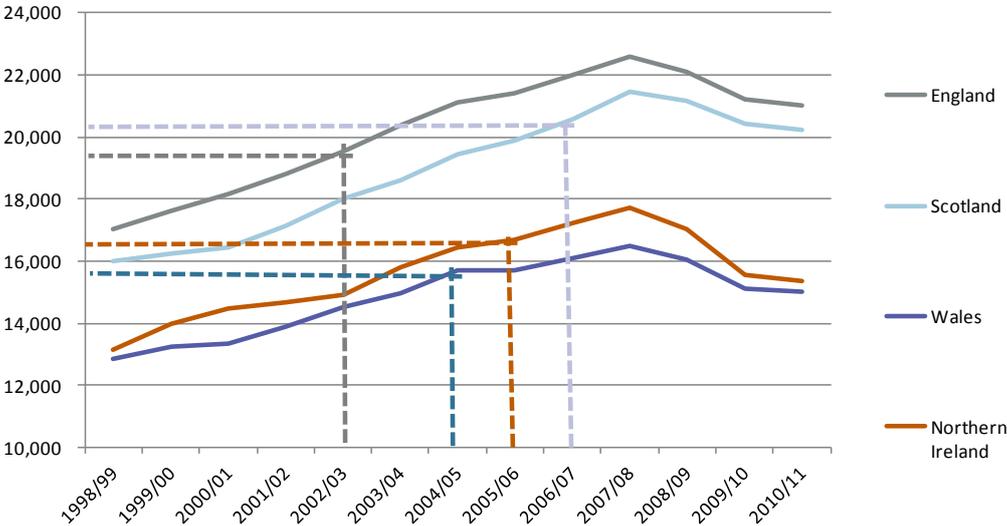
**Figure 31** Overview of drivers of waste arisings



The waste Kuznets curve hypothesis (based on the theory of the environmental Kuznets curve<sup>9</sup>) suggests that, once GDP reaches a certain level, waste arisings will start to reduce (i.e. absolute decoupling of waste from GDP occurs). There is evidence of this occurring for municipal waste in Japan (Ichinose et al, 2011); however, this has not been found to be true in previous multivariate regression analysis of municipal waste at the EU level (Mazzanti and Zoboli, 2009). Ichinose et al (2011) suggest that one of the potential reasons that Mazzanti and Zoboli (2009) failed in verifying the hypothesis is that they used country-level data<sup>10</sup>.

Further to this, Mazzanti et al (2008) suggests that the level of per capita GDP at which absolute decoupling of MSW in Italy starts would be in the range of 24,000 to 27,000 Euros (£19,416 to £21,843<sup>11</sup>). To consider whether the UK nations have reached an equivalent threshold level, Figure 32 compares the GVA per capita at the point in time at which Household waste arisings initially begin to fall (see section 4.1) in England (2002/03), Scotland (2006/07), Wales (2004/05) and Northern Ireland (2005/06).

**Figure 32** UK nations total GVA (2010 £) per capita compared to first year of fall in Household waste arisings (broken lines indicate points at which waste per capita started to fall)



Source: GVA – ONS website - Regional Gross Value Added, annual figures

The UK nations Household waste arisings trends tentatively confirm the waste Kuznets curve hypothesis and indicate a threshold range of between approximately £15,500 and £20,500, similar to the range suggested by Mazzanti et al (2008). There is however significant variation in the threshold between the UK nations, as the figure shows.

<sup>9</sup> The environmental Kuznets curve hypothesis suggests that an economy tends to degrade its environmental quality during its initial economic growth, but that beyond a threshold point in its economic growth its environmental quality then starts to improve as per-capita income continues to grow (i.e. environmental impact indicator is an inverted U-shaped function of income per capita) (Van Alstine and Neumayer, 2009).

<sup>10</sup> Ichinose et al. (2011) state that the successful result is partly due to the highly disaggregated data and also to the use of the spatial econometric model that takes into account the mimicking behaviour among neighboring municipalities; "the former indicates that distinguishing between household and business waste is the key to revealing the waste-income relationship, while the latter implies the importance of peer effects when municipal governments formulate waste-reduction policies".

<sup>11</sup> 2008 exchange rate of 0.809 GBP per Euro.

With regard to future trends for economic growth and waste arisings, Sjoström and Ostblom (2010) model the waste intensity outcomes in a 'Decoupling scenario' and a 'Baseline scenario' of the Swedish economy from 2006 to 2030<sup>12</sup>. They find that, to offset the effect of economic growth in the 'Decoupling scenario', the intensities of material-related wastes must decrease at twice the annual rate of historic reductions (1% per annum) used in the 'Baseline scenario'; for the waste intensities related to production and households, the reduction must also be significant compared to the 'Baseline scenario'. The conclusions emphasise the strength of measures needed to attain absolute decoupling in future.

## 5.2 Selection of potential drivers for analysis

In order to assess which drivers may influence the degree of coupling or decoupling, indicators considered relevant as proxies for potential drivers of waste arisings have been identified. Table 3 summarises the potential drivers described in the literature (shown in Figure 31), relevant variables for these and potential proxy indicators. The availability of data for these is also listed. No proxy indicators were apparent for competition and legislation, however case studies of policy measures are discussed in Chapter 6.0.

In many cases proxy indicator data at the UK level cannot be linked to the decoupling conclusions, as the conclusions are at the UK nation level. The following proxy indicators however, were selected for quantitative and qualitative analysis, based on the findings of the literature review and available data for proxy indicators:

- for the quantitative analysis of potential drivers of Household waste: population, HE (relevant categories – see Appendix 3), GVA (relevant categories – see Appendix 3), GDHI, claimant count, average household size and landfill tax rates;
- For qualitative analysis: the drivers highlighted by the regression analysis and GKEWM across the nations.

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<sup>12</sup> Model projections link waste generation to firms' material input, firms' production and households' consumption.

**Table 3** Potential Household waste drivers summary table

Potential driver	Variable	Proxy indicators	Comment	Available for UK nations?
Population	Population growth	% change in population	The indicator is a direct representation of the potential driver.	Yes
Consumption (business)	Material use	Direct material input (DMI) and/or domestic material consumption (DMC)	The indicator is a direct representation of the potential driver. However, DMI and DMC are economy wide indicators for material use. They cannot be directly related to specific business sectors.	UK level only
Consumption	Expenditure	HE (per Household)	The indicator is a direct representation of the potential driver.	Yes
Consumption	Purchasing trends	Relevant HE categories (see Appendix 3)	Household purchasing trends could provide a better understanding of the actual drivers of waste arisings.	Yes
Increased economic activity	Changes in relative size of waste generating activities	Relevant GVA categories ( see Appendix 3)	GVA is an accepted proxy for the economic activity of a sector.	Yes
Affluence	Income	GDHI	It was seen that income is not necessary coupled to waste arisings. Income could however be a driver for household expenditure itself.	Yes
Lifestyle	Growth of the 'experience' economy	Components of HE (see above).	Spending on experiences rather than goods; services, food could be important.	Yes
Behaviour/practices	Interest in sustainability issues	Membership to sustainability NGOs	Might not be representative. Indicator is at UK level and cannot be related to individual UK nations. Does not guarantee change in behaviour.	UK level only
Behaviour/practices	Desire to reduce waste	Numbers of Mail Preference Service subscribers	Indicator is at UK level and cannot be related to individual UK nations. Does not guarantee change in behaviour – may be driven by desire to avoid nuisance, rather than waste-awareness – and therefore might not be representative.	UK level only
Behaviour/practices	Perceived effect of climate change (CC)	% of individuals who claim CC is a major problem	Might not be representative. Indicator is at UK level and cannot be related to individual UK nations. Does not guarantee change in behaviour.	UK level only; not obtained
Behaviour/practice (business)	Implementation of resource efficiency measures in organisations	Number of organisations with registered environmental management system according to EMAS and ISO 14001	Might not be representative and is an economy wide indicator (cannot be directly related to specific business sectors). Does not guarantee change in behaviour.	UK level only
Behaviour/practice (business)	Interest in sustainability issues	Number of organisations publishing environmental, sustainability, etc. reports according to the Global Reporting Initiative standard	Might not be representative and is an economy wide indicator (cannot be directly related to specific business sectors). Does not guarantee change in behaviour.	UK level only

Potential driver	Variable	Proxy indicators	Comment	Available for UK nations?
Behaviour/ practice (business)	Business resource efficiency programmes, e.g. Envirowise	Funding for Envirowise	The indicator is a direct representation of the potential driver. However, it does not guarantee change in behaviour.	Available for area covered by initiative; not obtained
Unemployment	Fall in unemployment	% reduction in claimant count	It was seen that unemployment is not necessarily coupled to waste arisings. Unemployment could however be a driver for household expenditure.	Yes
Household size	Increase in single society living	Population per household	The indicator is a fair representation of the potential driver.	Yes
Urbanisation	Growth in urban population	Urban population (% of total)	The indicator is a direct representation of the potential driver. However, it is at UK level and cannot be related to individual UK nations.	UK level only; not obtained
Waste management costs (to business)	Landfill tax	Landfill tax rates	The indicator is a partial representation of the potential driver (there will be other costs associated with waste management). It is at UK level and cannot be related to individual UK nations.	UK level only
Local infrastructure	Funding for waste management including waste prevention measures	Government spending on waste management (GKEWM)	The indicator may to an extent represent the potential driver; however, as the indicator is also an outcome of waste arisings, there may be simultaneous causality. In addition, spending on waste management has historically targeted diversion from the residual stream, or from landfill, and only more recently been aimed at waste prevention.	Yes
Product design	Shortening product life cycle	<i>No indicators identified</i>	-	-

### 5.3 Quantitative analysis of potential drivers of household waste

A statistical analysis (multivariate regression) of the links between waste and the wider economy, using data on Household waste arisings for England, Scotland, Wales and Northern Ireland for the period 1998-2011, was conducted to quantitatively analyse the relationship between waste arisings and proxy indicators selected to represent potential drivers. Detail of the analyses is provided in Appendix 4.

Only data for the Household stream was sufficient (in terms of primary data available) for this form of regression analysis (and not for C&D, commercial or industrial waste streams). The indicators of HE, GVA by sector, household size and total population were used; the analysis also evaluated the effects of the Landfill Tax. In terms of diagnostics, the chosen regression appeared well determined and all explanatory variables were statistically significant ( $R^2$  value of 0.82<sup>13</sup>; see Appendix 4 for further details). Other variables were tried (different combinations of sectoral GVA, claimant count, GDHI) but none were consistently significant in explaining trends in Household per capita waste arisings.

Dummy variables indicate that England has the lowest per capita Household waste while the other UK nations all have higher levels, and the differences between nations are statistically significant (see Appendix 4 for further details).

The most robust and statistically significant results were as follows:

- a. The effect of a 10% increase in GVA per capita (in real terms) would result in a 3% increase in Household waste per capita per year.
- b. A reduction in mean household size by approximately 10% (from 2.44 to 2.19 across the sample) would result in a 7.7% increase in waste per capita.
- c. An increase in expenditure on other snacks and takeaway of ten per cent would increase waste arising by 1.5 per cent per capita.
- d. An increase in the landfill tax of 10% in real terms would reduce Household waste arisings by 0.02%.

The GVA coefficient indicates that there is relative decoupling in this sample: as GVA increases, waste arising increases but at a slower rate. This is in line with the historic analysis of primary data carried out in section 4.5.1. The regression also confirms that household size is important: the smaller the size the greater the waste per capita. Thirdly, the landfill tax is strongly correlated with Household waste arisings and has a small but statistically significant effect on per capita waste; it is noteworthy that the landfill tax has the effect of reducing Household wastes arisings.

However, further data are needed to better understand the factors that explain the different performance of the four UK nations, and it is likely that there are other variables that have been omitted which may bias the estimated coefficients (i.e. the regression is not capable of fully capturing the true relationship between waste and all its drivers). Although the results are statistically significant, it cannot be said with complete confidence that there is a causal relationship<sup>14</sup>. There are however good theoretical reasons for wastes to be affected by the chosen variables, and so the interpretation of some possible causal link is not unreasonable.

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<sup>13</sup> The  $R^2$  value is a statistical measure of how well the regression line approximates the real data points (a value of 1.0 indicates that the regression line fits the data perfectly).

<sup>14</sup> It would be desirable to conduct further tests on the time series for causality. One such test is the Granger causality test, which checks if lagged values of one variable better predict out of sample values of the other, or vice versa. Unfortunately the data were very limited; losing two years to establish the lags and two years to test out of sample predictions would not leave enough observations to estimate the underlying regression satisfactorily.

## 5.4 Qualitative analysis of potential drivers

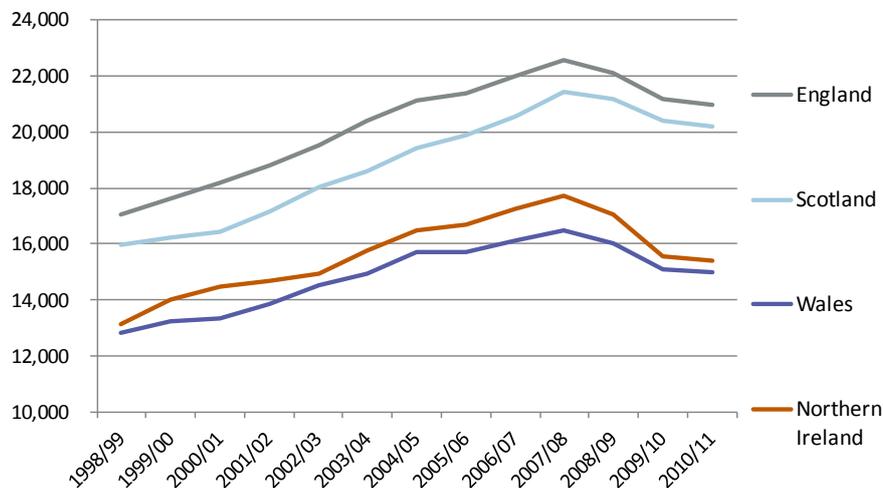
This section reviews trends in proxy indicators for which data at the UK nations level is available. Consideration is made on whether the potential drivers they represent could be leading to the differences observed between UK nations' waste arisings trends and differences observed in decoupling of the arisings from economic indicators.

### Household waste stream

England appears to produce the lowest level of Household waste, whether per capita (from 2003/04 onward), or per unit GDHI or HE (across the period reviewed). In order to consider what might be driving this comparatively low level, the indicators identified as having most effect on Household waste arisings during the regression analysis are further investigated.

Figure 33 shows that total GVA per capita is greatest in England; a low per capita GVA does not appear to be the driver of low per capita Household waste arisings in England.

**Figure 33** Total GVA (2010 £) per capita



Source: GVA – ONS website - Regional Gross Value Added, annual figures

Figure 34 shows the population per household in UK nations; high population per household does not appear to be driving the low per capita Household waste arisings in England.

**Figure 34** Population per household

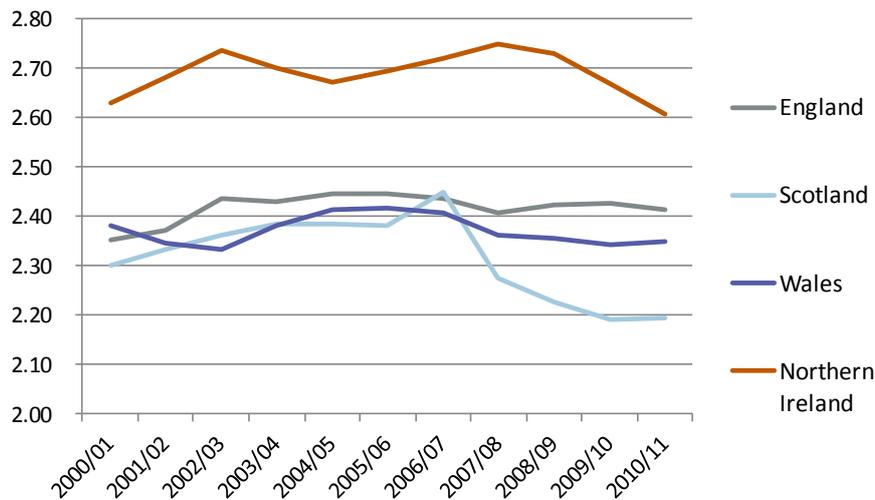
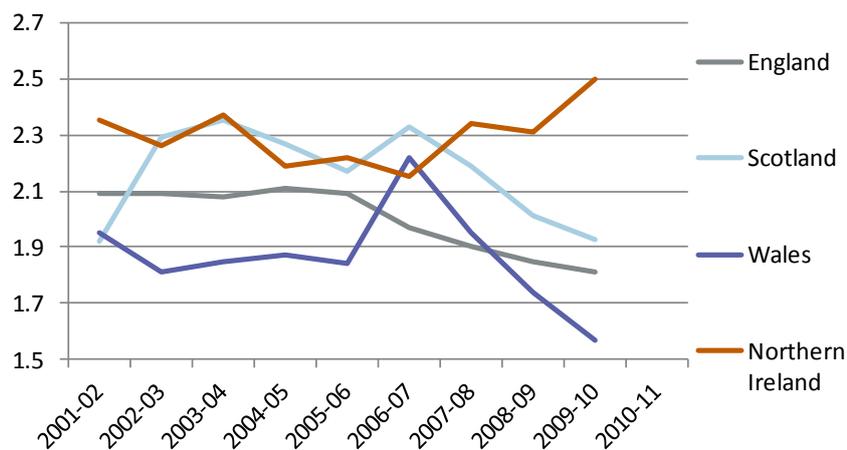


Figure 35 shows the HE on the category "Other take-away and snack food"; expenditure on this category in England does not appear to be driving the low per capita Household waste arisings in England.

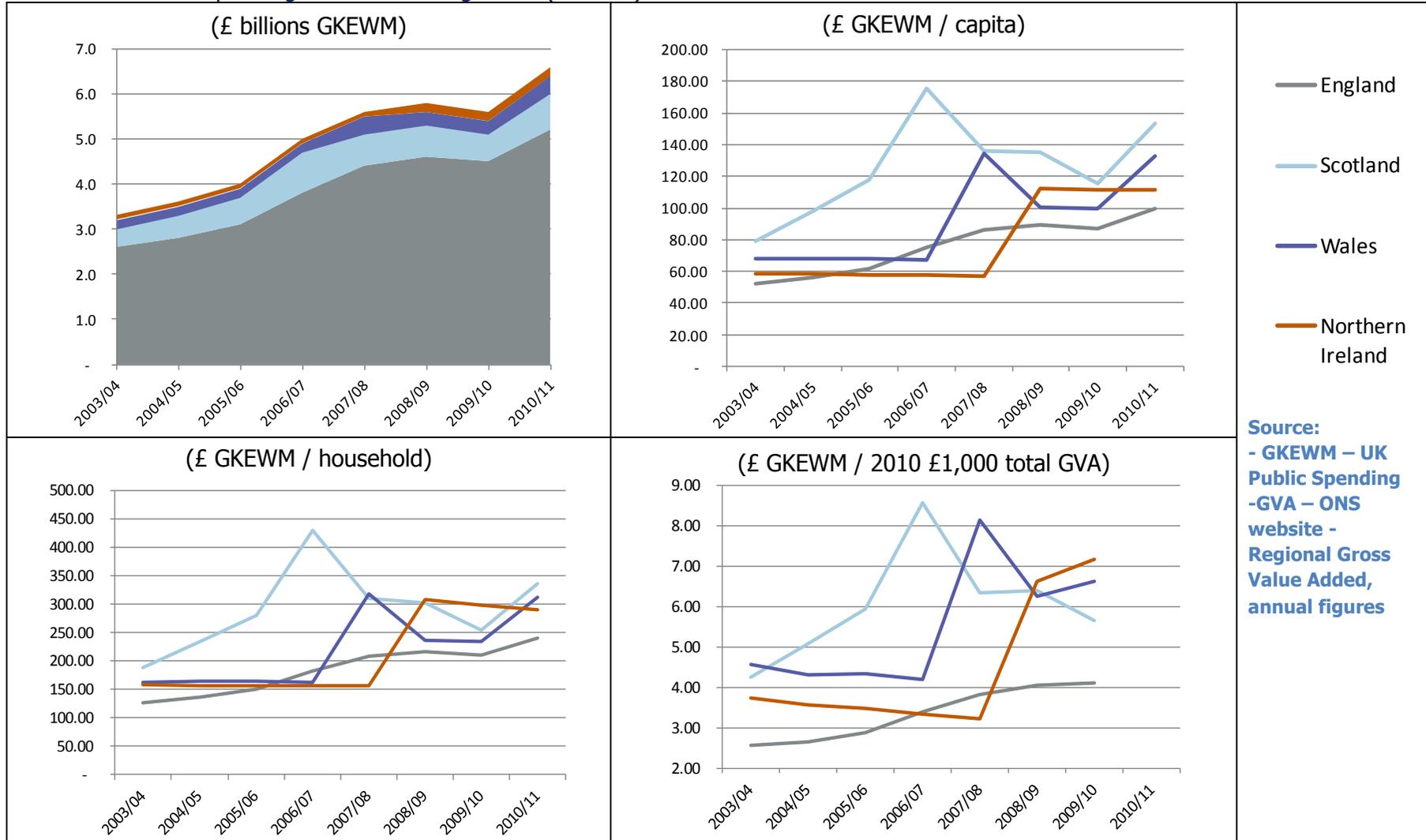
**Figure 35** HE on "Other take-away and snack food" (2010 £ / capita / week)



Source: Household expenditure – ONS website, Family Expenditure annual reports

Figure 36 shows total Government spending on waste management across the UK nations, and spending per capita, per household, and per unit total GVA. The amounts vary significantly across the period and between nations.

**Figure 36** Government spending on waste management (GKEWM) across the UK nations



Although Government spending on waste management has been high in total for England, it has been comparatively low in England when considered per capita, per household or per unit total GVA. Hence, Government spending on waste management in England does not appear to be driving the low per capita Household waste arisings in England, although there may be scale effects due to high total spend in England.

However, this qualitative analysis considers only a selection of the potential drivers; others described in Table 3, such as behaviours and practices (developed through education and environmental awareness), could be factors that influence the lower levels of waste per capita in England.

## 5.5 Conclusions

The literature suggests that there are many drivers that have positive or negative effects on waste arisings. However, there were limited opportunities to analyse the factors that lead to decoupling of commercial, industrial or C&D waste arisings, due to:

- the quality issues concerning waste arisings data and lack of robust conclusions on decoupling for commercial and industrial waste; and
- the fact that trends in proxy indicators are often available only at the UK level and hence cannot be linked to the decoupling conclusions for C&D waste, as these are at a UK nation level.

The regression analysis of Household waste supports the qualitative analysis of decoupling for this waste stream, confirming relative decoupling has occurred. The regression demonstrates significant correlation between certain proxy indicators and waste arisings, suggesting that drivers include:

- household size, with smaller households generating more waste per capita;
- increased household expenditure on snack and takeaways, increasing waste arisings; and
- the Landfill Tax, which has the effect of reducing Household wastes arisings, contradicting the findings in the literature (however, the effect size is small).

The findings suggest that economic disincentives (e.g. Landfill Tax) may drive some reductions in Household waste. Review of the trends of the three drivers' proxy indicators for each of the UK nations does not, however, clarify what factors have led to the relatively low Household waste arisings per capita in England observed in Chapter 3.

With regard to options for further work, investigation of the factors that influence waste generation across different household sizes (i.e. analysis of what really makes a small household generate more waste per capita than a bigger household) may reveal further evidence on the drivers of waste. The literature also suggests that quantitative analysis of trends at a disaggregated level, such as municipal-level data, may provide greater insight into drivers of waste arisings.

## 6.0 Waste prevention strategies and measures

This chapter presents a discussion on types of waste prevention strategies and suggests measures that might be used to achieve these. It also presents the evidence on the impacts of waste prevention measures already being implemented.

As highlighted in section 1.1, the focus of this study is on potential reductions in volume of wastes. Section 3.0 concludes that the highest volume waste stream for decoupling is C&D waste, and highlights variation in Household waste arisings across the UK nations. Arcadis (2010) suggests that, based on volume of waste created, minerals (mostly present in C&D waste), food, and paper and cardboard are significant waste streams. In addition, Arcadis (2010) suggest hazardous wastes and metals are important waste streams based environmental impacts and hidden material flows.

### 6.1 Waste prevention strategies

Waste prevention programmes are “general plans of action” to meet policy objectives. Specific waste prevention programmes are anticipated for all nations in line with the Waste Framework Directive requirement by December 2013. Each programme can promote a range of waste prevention strategies (e.g. lean production), which are delivered through the implementation of a range of measures (e.g. a voluntary agreement). In Appendix 5, Table 7 summarises the targets proposed in current national waste strategies. Wales is the only UK nation to have set a specific waste reduction target in advance of this, with the Scottish Government consulting on reductions through ‘Safeguarding Scotland’s Resources’ in 2012 (Scottish Government, 2012). Targets in other nations may have an impact on waste prevention.

Waste prevention targets in other EU Member States are summarised in Table 4. These provide an indication of levels of ambition.

**Table 4** Waste prevention targets from the investigated waste management plans (BIO Intelligence Service, 2011a)

Country/region	Target
Flanders	Keeping MSW constant at 560 kg/capita/annum by annually preventing or reusing 2% of the dry fractions in household waste, to offset the autonomous growth of the waste volume
Bulgaria	<ul style="list-style-type: none"> <li>- MSW: 400 kg/capita/annum;</li> <li>- Industrial waste quantity per unit gross domestic product (GDP) is stabilised at the year 2001 level;</li> <li>- Hazardous waste generation is reduced as compared to the year 2001 level</li> </ul>
France	7% reduction of household waste within 5 years
Hungary	<ul style="list-style-type: none"> <li>- The total mass of waste generated that needs to be treated shall not exceed the 2000 level;</li> <li>- Waste generation per unit of GDP (273kg/1000 USD GDP in Hungary in 1998) shall be decreased to the average EU level.</li> </ul>
Netherlands	The limits of total Dutch waste generation are 68 million tonnes in 2015 and 73 million tonnes in 2021.
Portugal	<ul style="list-style-type: none"> <li>- 10 % reduction of per capital municipal waste generation (from approx. 470 kg/capita in 2006 to approximately 423 kg/capita in 2016).</li> <li>- 12.1% reduction of industrial waste generation in 19 industrial sectors as compared to the scenario in which no prevention measures are applied</li> </ul>
Spain	<ul style="list-style-type: none"> <li>- Residual waste produced: 2008 = 524 kg/capita, 2010 = 472 kg/capita, 2015 = 419 kg/capita.</li> <li>- 10% reduction in the weight of packaging from 2010 (target for the manufacturing industry)</li> <li>- 4% reduction of packaging waste by 2012 as compared to 2006; 50% reduction in the use of commercial plastic bags from 2010 and progressive prohibition;</li> <li>- 50% reduction in ‘junk’ mail from 2012 onwards.</li> <li>- 8% reduction in hazardous waste produced by 2011 and 15% reduction by 2015;</li> <li>- 7% reduction in non-hazardous industrial waste by 2012 and 10% by 2015.</li> </ul>

In addition to differences in targets set, the types of measures proposed differ significantly between the UK nations, with England and Northern Ireland proposing to use a greater variety of measures in their existing waste management plans. However, as discussed in section 1.1, Article 29 of the WFD requires Member States to establish waste prevention programmes by December 2013, including setting objectives and monitoring progress via benchmarks.

An overview of types of measures which can be taken to address waste drivers is shown in Figure 37. The illustrative figure is based on the DPSIR framework discussed in section 1.1. Waste prevention responses can take numerous forms, focusing on drivers of waste generation.

There are a number of waste prevention strategies to consider, including those indicated in WRAP's report Meeting the UK Climate Challenge (WRAP, 2009), notably:

#### **Production-oriented strategies:**

- lean production in UK industry;
- material substitution, which may have indirect benefits to waste prevention through reducing the amount of waste created;
- waste reduction in UK commerce and industry;
- dematerialisation of the service sector;
- sustainable buildings (i.e. ecodesign for buildings); and
- efficient use of existing infrastructure.

#### **Consumption-oriented strategies:**

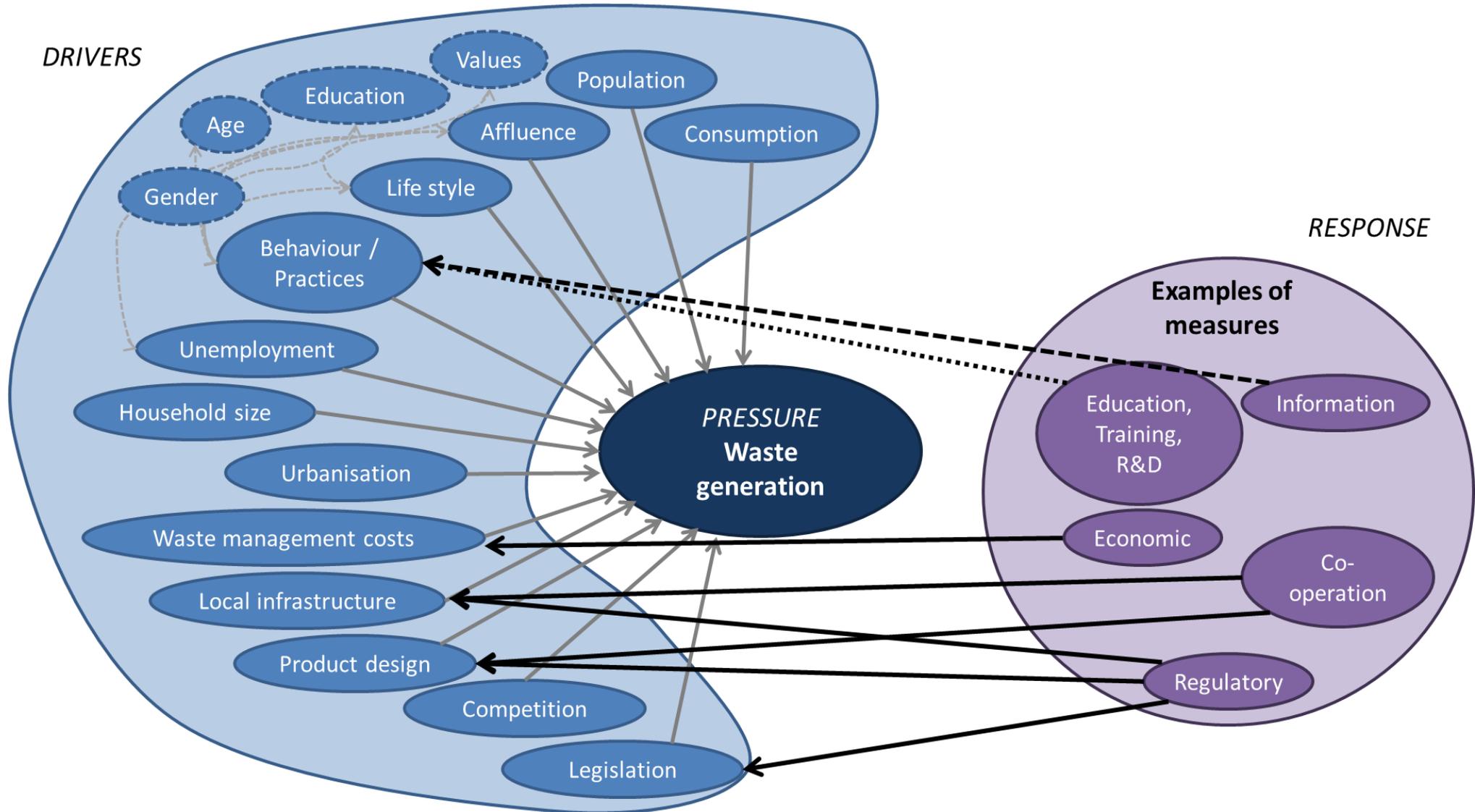
- lifetime optimisation;
- fostering "goods to services" practices;
- encouraging a restorative economy;
- public sector procurement;
- dietary changes (i.e. similar to material substitution but for consumers); and
- reducing food waste (i.e. similar to waste reduction but for households).

The above-mentioned waste prevention strategies are generally achieved by:

- **directly reducing waste** (e.g. waste reduction);
- **reducing the amount of materials consumed** and thereby indirectly reducing the amount of waste generated (e.g. lean production, ecodesign, sustainable procurement, dietary changes, etc.); or
- **improving the use of products and infrastructure** in order to reduce the consumption of products and construction of new infrastructure, which again in turn reduces the amount of waste generated (e.g. dematerialisation, lifetime optimisation, etc.).

The waste prevention strategies can be generally applied to different sectors, e.g. industry, construction, retail, households, public sector, etc. It should be noted that some of these strategies can be mutually supportive, while some of them may result in conflicts. For example, reducing the amount of materials in products, may compromise the durability and lifetime of these products. Innovation, in the development of cleaner technologies, more efficient use of natural resources and new economic and consumer models, such as service-based and reuse systems, are also crucial for achieving decoupling.

**Figure 37** How waste prevention measures impact on the drivers of waste generation



## 6.2 Waste prevention measures

A number of measures can be used to implement waste prevention strategies and incite waste prevention actions. These can be characterised as:

- **Regulatory instruments:** setting specific requirements to product and processes such as environmental permits and product standards.
- **Economic instruments:** market-based instruments that use economic variables to provide incentives. This includes taxes, fees, trading certificates, subsidies and extended producer responsibility schemes.
- **Research, development and deployment:** financial and non-financial incentives to promote R&D and technology transfer.
- **Cooperation:** agreement among a group of stakeholders to achieve a specific target together.
- **Education and training:** support to build capacity and raise awareness.
- **Information based measures:** using information on the environmental performance of products or organisations to encourage waste prevention. This includes ecolabels, sustainable procurement criteria, environmental management systems, environmental monitoring, information centres, etc.

Rather than a single measure, typically a mixture of measures are best suited to support each of the waste prevention strategies; the development of waste prevention strategies should consider combinations of measures, both “hard” (i.e. economic disincentives) and “soft” (i.e. awareness campaigns) measures, in order to have greater effect (Fell et al, 2010; BIO Intelligence Service, 2012b). Cost-effectiveness is important and, due to likely variability in costs of measures, trade-offs may be required where resources are limited (this aspect is not analysed but recommended as further work in section 6.6).

Regulatory measures such as product standards (e.g. durability, recoverability, reusability, recyclability (European Commission, Joint Research Centre, 2012) can be effective to support better use of products. If complemented with a measure to initiate extended producer responsibility, this would further improve the use of products. For example, take back obligations would increase recoverability, reusability and recyclability. Extended product guarantees would encourage manufacturers to produce more durable products that could be easily repaired. In a similar manner, building standards could be used to ensure that buildings can be easily refurbished. Restrictions on the use of certain substances can be used to reduce the consumption of materials due to their environmental impacts (e.g. RoHS). Waste disposal restrictions and environmental permits can help prevent waste in industry. As discussed, cost-effectiveness is important, and costs to business of these types of measure should be considered in advance of implementation.

According to BIO Intelligence Service (2012a), economic instruments considered as having the most significant attributable impacts on waste are:

- Charges for waste disposal and treatment:
  - Landfill taxes and fees (and restrictions/bans to provide context for the charges);
  - Incineration taxes and fees (and restrictions/bans to provide context for the charges);
- Pay-as-you-throw (PAYT) schemes; and
- Producer responsibility schemes for specific waste streams (notably packaging, WEEE, ELV and batteries).

Economic instruments could also be applied to encourage better use of products, such as deposit schemes.

Support of research and development of more resource efficient technologies could help to reduce waste and the consumption of materials. Technology development is applicable for all types of waste prevention strategies. Support of R&D in behavioural issues and new business models (e.g. dematerialisation, restorative economy, etc.) could be particularly well suited for improving the use of products.

Measures based on cooperation, such as voluntary agreements for waste prevention (e.g. Courtauld Commitment) have also proven to be effective.

Education and training can help to build skills and capabilities for all types of waste prevention strategies.

Information-based measures such as environmental management systems are effective for businesses to track their material consumption and waste generation. For example, business resource efficiency programmes such as WRAP and ENWORKS have shown to be effective to support businesses with reducing both their material consumption and waste. These programmes use a mixture of measures such as awareness raising, auditing, consulting and training.

Measures that promote the most resource efficient products and services by providing information on their environmental performance such as ecolabels and Green Public Procurement are best suited for helping procurers and customers to choose the most resource efficient products and services.

The above listing of waste prevention measures shows that decision makers have a wide range of options available to implement each of the waste prevention strategies. A mix of different measures have shown to be more effective than individual measures, but the optimal mix of measures will depend on the individual sector and material/waste category.

### 6.3 Case studies of waste prevention measures

The impacts on waste arisings of waste prevention measures are quantified in some cases, through impacts analyses and case studies, providing indication of their role in driving waste reduction; [Table 5](#) provides examples of the impacts of measures for which information has been found. Economic instruments, as well as cooperation and information based instruments appear to be effective in supporting decoupling in some cases. With regard to cooperation, metrics and targets set within industry agreements for C&D waste should include waste prevention as well as diversion from landfill (i.e. reuse).

**Table 5** Waste prevention measures – case studies

Waste stream					Measure / Geog. Scope	Evidence	Quantified evidence of waste prevention and considerations on decoupling	Sources
LACW /House /hold	Comm.	Ind.	C&D					
<b>Economic instruments:</b> market-based instruments that use economic variables to provide incentives and disincentives, including taxes, fees, trading certificates and subsidies.								
✓	✓	✓	✓	Landfill tax (EU)	Regarding Household waste, early analysis of the UK Landfill Tax concluded that the landfill tax did not affected the quantity to any significant degree, due to the lack of incentives provided for behavioural change in households; municipal waste in fact increased, due to a shift in materials from one waste stream to another to avoid the tax <sup>15</sup> . With regard to analysis across the EU, some analysis finds that landfill taxes can reduce waste arisings to a certain extent, however other evidence suggest that they do not. Regarding the other waste streams, C&D waste has been shown to have undergone the greatest change and Oakdene Hollins (2011) suggests that the relationship between reduced commercial and industrial waste arisings and the standard rate of landfill tax also appears convincing "...even if the causality is less straightforward; with some of the effect attributable to other policies."	Quantitative analysis in section 5.3 shows correlation of decline in Household waste to the UK Landfill Tax rates, suggesting it has had a small effect; evidence in the literature is inconclusive, although indicates that landfill tax is effective in reducing other wastes, including C&D waste. No evidence on economic impact.	Ecotec (2001), van den Bergh (2008), Mazzanti and Zoboli (2009), Oakdene Hollins (2011) BIO Intelligence Service (2012a)	
✓	✓	✓	✓	Pay as You Throw (PAYT) (EU + Switzerland)	A number of EU MS have implemented PAYT systems, based on volume, frequency, weight, or sack. The results differ from one country to another. In Austria, increased PAYT fees had a limited dampening effect on waste generation. In Germany, a weight-based PAYT scheme at regional level achieved a significant reduction in household waste generation. In Switzerland, the issue of fly-tipping of household waste on the pavements, following introduction of PAYT, has raised the concern that its effects may be disproportional. <sup>16</sup>	22,000 tonnes to around 8,000 tonnes (64%) reduction of household waste generation for a regional scheme in Germany. However, the literature suggests that effects are likely to vary significantly at a local scale. No evidence on macro-economic impact.	Repetto et al. (1992), OECD (1993), Eunomia (2011), Land Economics (2011), BIO Intelligence Service (2012a), Tages Anzeiger (2012) <sup>17</sup>	
		✓		Chemical leasing (Austria)	A pilot project started in Vienna in 2005 tested the possibility of moving the chemicals market to a service market, in which the consumer pays for a service provided by the chemicals and not by the chemical products. These projects were run in parallel in Austria and some developing countries such as Mexico, Egypt, and Colombia.	It is estimated that this model could save 53,000 tons of chemicals in Austria per year. No evidence on economic impact.	Wuppertal Institute (2010)	

<sup>15</sup> This can be done by people taking trade waste to Civic Amenity sites, taking it home to dispose of with household waste or through illegal dumping (Ecotec, 2001).

<sup>16</sup> The issue is concentrated in the poorest areas of the city where around 13% of household waste is illegally dumped on pavements, etc.; this is set against a figure of 5.3% in the city overall and 2.3% in the most affluent area. The article suggests that in the poorer areas the pay as you throw system is prohibitive and may also be due to cultural attitudes.

<sup>17</sup> The Tages Anzeiger is one of the principal 'broadsheets' in the canton of Zurich.

Waste stream					Measure / Geog. Scope	Evidence	Quantified evidence of waste prevention and considerations on decoupling	Sources
LACW / House hold	Comm.	Ind.	C&D					
✓				Extended producer responsibility (France)	The household packaging EPR chain, established in 1992, was the first large-scale chain to be set up in France, and it has fostered progress in reducing the unit weight of packaging. Between 1997 and 2009, the tonnage of packaging of 8 segments <sup>18</sup> of the household packaging market decreased by 20% (about 300,000 tonnes). <sup>19</sup>	Overall, for these 8 markets, there is a significant decoupling between consumption growth products (1%) and for tonnage household packaging implemented (- 20%).	ADEME (2011), ADEME (2012)	
<b>Cooperation:</b> agreement among a group of stakeholders to achieve a specific target together.								
			✓	Halving Waste to Landfill (UK)	Voluntary agreement within construction industry. Contractors setting baseline performance for waste have reported that their activities across the UK have resulted in 16.9 million tonnes of CD&E waste. Of this, 73% of arisings are recovered with only 4.6 million tonnes of waste being sent to landfill. For 2009 the total waste arisings decreased slightly in absolute terms but waste sent to landfill was cut by 28% – approximately 900,000 tonnes.	Results regarding waste focus on disposal behaviour; little evidence of significant effect on waste prevention.	WRAP (2011d)	
			✓	WasteWise Construction programme (Australia)	The programme ran between 1995 and 2001, and consisted in a voluntary agreement between the Government and major companies in the C&D industry to reduce the amount of C&D waste. The participants identified and addressed the technical and behavioural barriers to reduce waste. A number of projects were carried out as demonstrations of waste savings, including steel, concrete, etc. For the participating organisations the WasteWise program has successfully decreased the amount of waste going to landfill, sometimes by more than 90%.	Results regarding waste focus on disposal behaviour; little evidence of significant effect on waste prevention.	Australian Bureau of Statistics (2006)	

<sup>18</sup> Yoghurts and similar; Fresh milk and UHT; Flat waters (incl favoured); Carbonated waters and (incl favoured); Beers and beer bases; Fruit juices and nectars; Edible oils; Powder and liquid laundry; Pre-sliced deli / pre-packaged; Shower and bath gels and shampoos

<sup>19</sup> Analysis identified three main causes of this decrease – 1. consumption effect: variation of the total consumption of products related to the evolution of population and consumption of individuals; 2. effects of packaging: reduced unit weight of packaging without material change; changing the material to change per unit weight of packaging; 3. capacity effect: such as changes in the characteristics the product to reduce the container volume (concentration of the products, for example). Material changes lead the reduction; the evolution of capacities also plays an important role; changes in unit weight appear less significant.

Waste stream					Measure / Geog. Scope	Evidence	Quantified evidence of waste prevention and considerations on decoupling	Sources
LACW / House hold	Comm.	Ind.	C&D					
✓	✓			Courtauld Commitment (UK)	Voluntary agreement between retailers, including waste reduction. Phase 1: 2005-2010, Phase 2: 2010-2012. The results of Phase 1 announced in September 2010 show that 670,000 tonnes of food waste and 520,000 tonnes of packaging have been avoided across the UK between 2005 and 2009. First year progress results of Phase 2 show that signatories are already half way to achieving the packaging reduction target and three quarters of the way to reaching the household food waste objectives. 35 major retailers have signed up. From 2005-2007 packaging growth was halted despite 1.8% growth in sector.	168,000 tonnes of food waste prevented per year. 130,000 tonnes of packaging prevented per year. Halt in packaging during period of growth indicates contribution to relative decoupling.	EC (2012 a and b), WRAP (no date)	
<b>Education and training:</b> support to build capacity and raise awareness.								
✓				Love Food Hate Waste (UK)	Love Food Hate Waste has helped 1.8 million UK households prevent food waste since 2007. WRAP works with the UK grocery sector, food industry, government and organisations such as the Food Standards Agency, to develop practical solutions and improved communications to make it easier for consumers to get the most from the food they buy, and to waste less of it. The reduction in annual UK household food and drink waste between 2006/7 and 2010 was around 1.1 million tonnes (around 13%).	Had the reduction in food and drink waste not occurred, consumers would have been spending at least £2.5 billion a year more on food and drink bought and thrown away <sup>20</sup> ; contributes to decoupling.	WRAP (2011c), EC (2012a and b)	
<b>Information based instruments:</b> using information to encourage waste prevention, including ecolabels, sustainable procurement criteria, information centres, etc.								
	✓	✓	✓	WRAP Business Resource Efficiency Programme (UK)	WRAPs Business Resource Efficiency Programme offered businesses of all sizes and sectors a range of free, independent and practical advice designed to improve their processes, profitability and competitiveness, with a focus on persuading businesses of the benefits of resource efficiency. It has helped UK businesses save over £2 billion and significantly reduce their environmental footprints. In terms of efficiency and value for money this represents a saving of £38 for business for every £1 invested by Government.	Results focus on environmental impacts; resource efficiency likely to lead to waste prevention. Significant savings achieved. Likely to contribute to decoupling.	Defra (2009a), Defra (2009b)	
	✓	✓	✓	ENWORKS (UK)	An independent partnership of organisations delivering environmental business support across the North West of England. ENWORKS has successfully delivered multiple regional projects, using a range of different funding streams, primarily from the European Regional Development Fund (ERDF) and UK Government agencies. Since 2001 19.4 million tonnes material savings and £135 million cost savings to date.	19.4 million tonnes material savings and £135 million cost savings to date. Likely to contribute to decoupling.	ENWORKS (no date)	

<sup>20</sup> Food inflation over this period was around 20%, therefore although the amount thrown away in the UK is now lower it is still costing about the same (approximately £12 billion).

Waste stream				Measure / Geog. Scope	Evidence	Quantified evidence of waste prevention and considerations on decoupling	Sources
LACW / House hold	Comm.	Ind.	C&D				
	✓	✓		National Industry Symbiosis Programme (UK)	Developed in 2005 as an 'independent facilitator' to help businesses in various sectors and of various sizes come together to find uses for unwanted materials by sharing assets, resources, logistics and expertise. Diverted more than 5.2 million tonnes of industrial waste from landfill, eliminated 357,000 tonnes of hazardous waste. Delivered member cost savings of £131 million. Prevented the use of 7.9 million tonnes of raw materials.	357,000 tonnes of hazardous waste prevented and £131 million savings; contributes to decoupling.	EC (2012a)
	✓	✓	✓	WasteWise initiative (USA)	Started by the EPA, provides planning for effective waste management and tools to measure progress. In 2009 it had more than 1,700 members in more than 54 industry sectors, reporting a waste reduction of more than 120 million tonnes.	120 million tonnes of waste prevented in 2009. No evidence on economic impact.	EC (2012a)
	✓	✓	✓	Eco-Management and Audit Scheme (EMAS)	Under EMAS information is provided through various ways such as websites, organisation of events, conferences and seminars, a Helpdesk, training materials, organisation of annual awards. There is good evidence that implementation of EMSs reduce waste arising. However, the reports do not permit distinction in attribution between landfill diversion, waste minimisation and waste prevention.	A German publishing and printing company reduced their consumption of printing paper from 22.93 tonnes of paper per million square meters of printed newspaper pages in 2007 to 22.56 tons in 2009. Medium and large enterprises save significant costs through resource savings. Likely to contribute to decoupling.	Oakdene Hollins (2011), EC (2012a)

The review of the literature found no quantified impacts for regulatory measures or research, development and deployment measures. Assessing the impact on decoupling in the case studies is challenging, as results provided are often:

- partial (i.e. either only reductions in waste arisings are measured or only economic impacts); or
- impacts are measured in different ways (such as measuring results of a combination of measures; or
- at different scales; or
- for specific waste types.

For example:

- The Flanders Waste Prevention Plan in Belgium implemented a range of tools to help households and SMEs, including “take-back” schemes. Since 1995, the quantity of residual waste was halved, and overall generation of waste had been approximately steady since 2000 (EC, 2012).
- The Vienna Waste Prevention Programme in Austria includes web exchange of used items, repair and service centers (RUSZ) and promotion of lifestyle change campaign. About 11,000 tonnes of waste of electronic waste per year is estimated to be saved by the RUSZ centres, while the flea market saves around 1,000 tonnes of electronic waste (Arcadis, 2010) (EC, 2012).

However, the effect of each specific measure on waste prevention, or the overall economic impacts are not described.

These issues presents limitations to deriving conclusions on the measures’ effectiveness in supporting decoupling and to comparison of results (where available) to prioritise types of measures. [Table 8](#) in Appendix 6 lists examples of measures where limited quantified impacts were found.

In addition, the evidence suggests that local infrastructure, such as separate food waste collections, can affect public behaviour, making the public more aware of the amount of food they throw away and changing their purchasing, consumption and disposal habits as a result; 1 million tonnes of food waste is estimated to have been prevented from 2006 to 2010 in the UK (BIO Intelligence Service, 2010; Resource Futures and WRAP, 2011).

#### 6.4 Rebound effect

Waste prevention can result in cost savings. Therefore, as discussed in section 1.3, when considering decoupling of waste from economic growth it is important to consider the potential direct, indirect and economy wide rebound effects associated with waste prevention measures (increased efficiency or cost reduction results in its increased consumption at micro- or macro-economic level), as it could limit the reductions in waste arisings (although there may be a welfare improvement if individuals are able to consume more). In addition, economic incentives and disincentives used as measures to achieve waste prevention may have an influence on behaviour and lead to rebound effects.

GVSS and BIO Intelligence Service (2011) discuss the evidence of direct rebound effects for certain sectors (with “take-back” reduction in estimated savings in the range 10-80%). Studies have been carried out showing the rebound effect for technologies and prices involving energy and water consumption, but there is very limited evidence in terms of the effect in the context of waste. Besides the evidence in WRAP (2009), regression analysis of

'pricing-by-the-bag' policy in Japan found that the rebound effect cancelled out the reduction of municipal solid waste after about 20 years (Usui, 2009). The study noted that initial waste reduction could be attributed to an "announcement effect" following the introduction of the measure, while the rebound effect was observed through "stomping" or over-packing and compressing waste in each bag and thereby increasing the weight of each bag (the policy was based on per bag of waste, not weight). Other older studies suggest that considerable levels of illegal disposal can be expected in response to price-based waste policies: up to 30% of a reduction in waste generation may be caused by an increase in illegal disposal (van den Bergh, 2008). In another study from the USA in the 1990s, it showed that after correcting for illegal burning and dumping, it turned out that the total weight of legal waste decreased somewhat but only very little (about 10%).

The indirect rebound effect should also be considered; any waste prevention measure that saves individuals or businesses money gives them additional purchasing power, which may be used to consume more of other waste-intensive goods or services. Attempts should be made to mitigate these by encouraging "better" consumption decisions.

With regard to economy-wide rebound effects, EEA (2010) highlights the issue of "hidden flows"; where there is apparent decoupling of waste arisings from economic indicators, this may be due to the fact that *"...for most countries this merely means that the economy has grown faster than the increase in the use of materials. Growing imports of raw materials and semi-manufactured products to replace domestic production may also have contributed to this decoupling effect... Simply put, much of the extraction and heavy production takes place elsewhere and no longer shows up on national material flow balances."* In other words, the embedded waste in imports should be taken into account; if the UK economy becomes less waste-intensive, it does not mean that there is a corresponding decrease in global waste intensity.

Estimates for the magnitude of the rebound effects for SCP policies beyond energy (most available rebound effect evidence is energy efficiency related) is a gap at present and further research is needed. One of the reasons there is debate on the rebound effect is because it is hard to measure and varies depending on the intervention, the type of products/ services/ resources investigated, as well as other related factors, e.g. price elasticity. Isolating the rebound effects from other factors that cause increased consumption is a key issue that needs resolution in the definition and measurement techniques for estimating the magnitude of rebound effects. Traditional economic models for measuring environmental policy savings do not cater for the rebound effect, but measurement approaches can include income/price elasticity studies (for direct rebound effects), econometric modelling, general equilibrium modelling and expenditure surveys; this lack of inclusion has contributed to scepticism on the significance of the effect.

It is important to note that evidence for a rebound effect for waste reduction policies has not yet been established; the direct effect would have to show that the measure that increased efficiency through waste prevention would result in more waste being generated. However, it may be possible, for example, that if food waste is reduced through better management, individuals could spend some of the money saved on buying more food, which may in turn increase packaging waste.

GVSS and BIO Intelligence Service (2011) proposes four approaches to address rebound effects in implementing measures:

- **Recognise and account for rebound effect in measures;** the first step is to recognise and account for rebound effect take back in projected environmental savings during evaluation, incorporating assessment criteria, e.g. price, income, substitutability, technology type, resource intensity of the production sector,

potential for perverse outcomes/burden shifting and time span of the intervention, in tools such as Regulatory Impact Assessment (RIA). A toolbox (ideally web based) to support awareness raising /engagement of decision makers on rebound effect facts and how to include them in design and evaluation of measures is proposed. The Department of Energy and Climate Change, which already accounts for direct rebound effects where they occur, using the Valuation of energy use and GHG emissions for appraisal & evaluation Guidance & Tool, provides an example to build on.

- **Use of an integrated mixture of measures encompassing fiscal, behavioural and technology;** where the rebound effect is significant, evidence shows implementing a consistent mixed measure approach, incorporating technology, fiscal and behavioural aspects, is suited to addressing direct rebound effects. Measures that can dampen rebound effects in the short term include raising the price or rationing supply, i.e. cap and trade schemes for industry or smart meters for consumers. It is however cautioned that taxes are distortive; where fiscal measures are uniformly applied across sectors they may be ineffective and lead to unnecessary costs (for example a uniform tax rate is not necessarily efficient as sectors differ in their responsiveness to cost changes). A sectoral approach targeting the differing influencing factors and consumer/market responses driving the direct rebound effects and economy wide respectively are required; however, these will come at a higher administrative cost and require a minimum knowledge of the sectors considered.
- **Sustainable lifestyles & behaviour change in consumers;** while common approaches to tackle direct rebound effects include provision of information on the consumption, measures to tackle indirect or economy-wide rebound effects are scarce. Such measures, promoting consistently sustainable lifestyles and accustoming consumers to assessing their activities with regard to their environmental impact, would need to be extensive and aim at a more profound change in the awareness and the priorities of consumers. Much rebound effect evidence cites the role of wider initiatives to reduce growth and consumption and overcoming the conflict that traditional economic models have where GDP growth is the main success factor; recent recognition of this in France and the UK with the consideration of introducing social and environmental well-being indicators and making GDP a measure of market activity only are relevant developments.
- **Awareness raising and education for leveraging behaviour change in business;** through inclusion of how to avoid inadvertently causing indirect rebound in awareness raising and capacity building tools. For example, the UK Green Claims Guide for business provides guidance for business on how to make good environmental claims; several examples are identified that show well intentioned, but misguided advertising using air miles to motivate other pro-environmental choices, e.g. replacing inefficient lighting with low energy light bulbs.

## 6.5 Windfall effect

As discussed in section 1.4, the windfall effect is a situation when an economic agent behaves in a certain way, and would have continued to behave in the same way even if the benefit had not been granted; hence the costs associated with the implementation of policies

could have been saved while still achieving the target. In the context of waste prevention and decoupling, any waste prevention that can occur independently of input of capital may aid in decoupling of waste arisings from economic growth, as the capital can be diverted to other activities (e.g. initiatives to promote innovation and stimulate economic growth).

There is almost no publicly available information on estimates for the windfall effect relating to waste incentive policies. However, drivers such as raised awareness and changes in environmental attitudes for household and municipal waste, and efficiency initiatives or increases in material costs for commercial, industrial and C&D waste, could lead to reductions in waste arisings without policy intervention.

BIO Intelligence Service (2012c) provides information on strategies to mitigate the windfall effect that could be applied to waste policies:

- The first strategy consists in better targeting the beneficiaries of a policy (based on criteria such as income or timing of entrance/exit from a policy).
- The second strategy consists in avoiding schemes based on incentives and subsidies when the windfall effect is likely to be important. In this situation, using other economic or regulatory instruments may lead to higher efficiency.
- The third strategy implies better coordinating subsidies and incentives in order to set clearer funding trajectories.

## 6.6 Conclusions

The evidence suggests that economic instruments, cooperation and information based instruments may be effective in reducing waste whilst maintaining or enhancing certain economic indicators. Further research is required to assess cost-effectiveness of the measures. With regard to cooperation, metrics and targets set within industry agreements for C&D waste could include waste prevention and reuse as well as diversion from landfill.

With regard to further work, the limits to the approach taken in this research may be overcome by looking into specific products in order to identify "effective" waste prevention measures; for example, it would be useful to focus analysis on the type of product that ends up as waste (e.g. food, electronic equipment, packaging, etc.), as waste prevention measures are often designed and implemented to target one "gesture" or one type of waste.

In addition, as recommended in the conclusions to Chapter 5, analysing data (to assess the drivers of waste arisings and effectiveness of waste prevention measures) at a disaggregated level may prove effective, as measures may be implemented at a local (municipal or regional) level. Another consideration for the assessment of the effectiveness of public measures is to what extent they induce behaviour changes that lead to waste prevention (in individuals or organisations).

Impact assessments should be carried out, where practical, in situations where different mixes of measures are considered, and rebound and windfall effects should be taken into account as part of these assessments. Consideration of the rebound and windfall effects can aid in the design of waste prevention strategies which seek to achieve decoupling of waste from economic growth, and to ensure a full understanding of impacts; particularly concerning issues such as economy-wide rebound effects.

# Appendix 1 References

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# Appendix 2 Local Authority Collected Waste data definitions

## **The following notes are from Defra (2011d):**

This note sets out the background to the change in terminology and definition of 'Municipal Waste' reporting in policy and statistical terms.

Previously the term 'Municipal Waste', as used in the UK, was used in waste policies and nationally reported data to refer to waste collected by Local Authorities. In fact the definition of Municipal Waste as described in the Landfill Directive includes both household waste and that from other sources which are similar in nature and composition, which will include a significant proportion of waste generated by businesses and not collected by Local Authorities. In 2010, negotiations with the EU Commission and consultation with the waste community redefined national targets and the effects of this change in relation to the EU Landfill Directive targets.

To remove ambiguity, 'Municipal Waste' is now referred to using the new definition; the agreed terminology arises from Defra's response to the 2010 consultation on meeting the EU Landfill Diversion Targets in England:

### ***Local Authority Collected Municipal Waste (LACMW)***

LACMW refers to the previous 'municipal' element of the waste collected by local authorities. That is household waste and business waste where collected by the local authority and which is similar in nature and composition as required by the Landfill Directive.

### ***Local Authority Collected Waste (LACW)***

LACW refers to all waste collected by the Local Authority. This is a slightly broader concept than LACMW as it would include both this and non-municipal fractions such as construction and demolition waste. LACW is the definition that will be used in statistical publications, which previously referred to municipal waste.

## **Notes from SEPA data sources:**

Until 2006/07, where commercial and industrial waste was collected by the council, where possible, this was reported separately. In 2006/07, the relatively small quantities of industrial waste (compared with commercial) were combined with 'other non-household'. From 2007/08 data was obtained from WasteDataFlow.

## **The following notes are from the Welsh Government<sup>21</sup>:**

### ***Definition of Local Authority Municipal Waste***

This includes household and non-household waste that is collected and disposed of by Local Authorities. It includes regular household collections, specific recycling collections, special collections of bulky items, waste received at civic amenity sites and waste collected from non-household sources.

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<sup>21</sup> Source – Rhiannon Jones, Welsh Government

Three different definitions are used:

(i) Local authority municipal waste excluding abandoned vehicles (includes rubble, incinerator residues, matter from beach cleansing and plasterboard but excludes abandoned vehicles).

(ii) Local authority municipal waste including abandoned vehicles (includes rubble, incinerator residues, matter from beach cleansing, plasterboard and abandoned vehicles).

(iii) National strategic indicator local authority municipal waste excluding abandoned vehicles (excludes rubble, incinerator residues, matter from beach cleansing, plasterboard and abandoned vehicles).

### ***Non-household municipal waste***

Refers to all waste collected by an authority or its contractors, other than wastes within Schedule 1 and 2 of the Controlled waste Regulations 1992. Includes any other wastes collected by an authority, such as municipal parks and gardens waste, industrial or commercial waste and waste resulting from the clearance of fly-tipped materials.

# Appendix 3 Breakdown of economic indicators

Table 6 provides review of HE and GVA indicator break-downs.

**Table 6** Analysis of Household expenditure and GVA indicators

Group	Measure/Year	Comment (data on spending is from 2010)
Household expenditure	Food & non-alcoholic drinks/household/wk	This is 26% of waste generating household spending.
Household expenditure	Maintenance and repair of dwelling/household/wk	This includes only DIY expenditure, and so is not an indicator of C and D waste. It was 1.5% of household spending in 2010, 3.5% of waste generating spending. Contracted building work to dwellings is included in <i>Purchase or alteration of dwellings, mortgages, under other items recorded</i> . The group category <i>other items recorded</i> is not included in the total of household spending.
Household expenditure	Recreation and culture/household/wk	The former is 12.5% of household spending, of which 5.9% is non-waste generating. The latter is 2.9% of household spending – not household waste generating
Household expenditure	Restaurant and café meals/household/wk	In order for these to be combined as indicator of spend on non-household waste generating categories it would be best to isolate non-waste generating elements from the former. As this is impractical – suggest these do not constitute a good variable.
Household expenditure	Clothing & footwear/household/wk	Former is 11.2% of waste generating spending. Latter is 2% of waste generating spending.
Household expenditure	Take away meals eaten at home/household/wk	These combined as indicator of spend on non-essential Household waste generating categories.
GVA at current basic prices - workplace based (£ million)	Agriculture, forestry and fishing	Sum of these categories as indicator of industrial waste generation. Manufacturing as an indicator of industrial.
GVA at current basic prices - workplace based (£ million)	Mining and quarrying	
GVA at current basic prices - workplace based (£ million)	Manufacturing	
GVA at current basic prices - workplace based (£ million)	Electricity, gas, steam and air-conditioning supply	
GVA at current basic prices - workplace based (£ million)	Water supply; sewerage, waste management	

Group	Measure/Year	Comment (data on spending is from 2010)
GVA at current basic prices - workplace based (£ million)	Wholesale and retail trade, repair of motor vehicles	Sum of these categories as indicator of commercial waste generation.
GVA at current basic prices - workplace based (£ million)	Transportation and storage	
GVA at current basic prices - workplace based (£ million)	Accommodation and food service activities	
GVA at current basic prices - workplace based (£ million)	Information and communication	
GVA at current basic prices - workplace based (£ million)	Financial and insurance activities	
GVA at current basic prices - workplace based (£ million)	Real estate activities	
GVA at current basic prices - workplace based (£ million)	Professional, scientific and technical activities	
GVA at current basic prices - workplace based (£ million)	Administrative and support service activities	
GVA at current basic prices - workplace based (£ million)	Public administration and defence; compulsory social security	
GVA at current basic prices - workplace based (£ million)	Education	
GVA at current basic prices - workplace based (£ million)	Human health and social work activities	
GVA at current basic prices - workplace based (£ million)	Arts, entertainment and recreation	
GVA at current basic prices - workplace based (£ million)	Other service activities	

# Appendix 4 Regression analysis

This appendix looks at statistical analysis of links between waste and the wider economy using data on waste arising for England, Scotland, Wales and Northern Ireland along with household spending data and GVA by sector for the period 1998-2011 (waste arisings data sources as described in Chapter 3). Also, household size and total population data had been provided and has been investigated.

The financial data (GVA and household spending) was deflated to 2010 £ using Consumer Price Index figures from the Office of National Statistics. These figures were annual and for a calendar year. Some of the household spending and GVA data were also for calendar years, but given in the form of tax years (April to April) to align with other data. Based on correspondence with Resource Futures, this seemed the most accurate way to proceed.

The data was combined to form a dataset with a number of categories, explained in the datasheet "Legend". This includes dummy variables for the four countries plus time periods. The dataset is arranged in the "long" format suitable for econometric panel estimation. A copy of the dataset is provided in excel format.

Regressions were made using the "Eviews" software, running a Least Squares panel regression. The panel is a so-called "unbalanced" panel since a number of key variables are missing for certain years. This means random effects cannot be estimated, so fixed effects are used. Heteroskedasticity was corrected for using White's Diagonal correction. Under the panel regression, the dummy variables for the countries are automatically taken into consideration. If the dummy variables are explicitly included, then the regression reverts to Ordinary Least Squares, but the coefficients and p-values for the dummies can be seen.

In a number of cases we have used logged variables – logged to base 10 – in order to strengthen the linear association between variables.

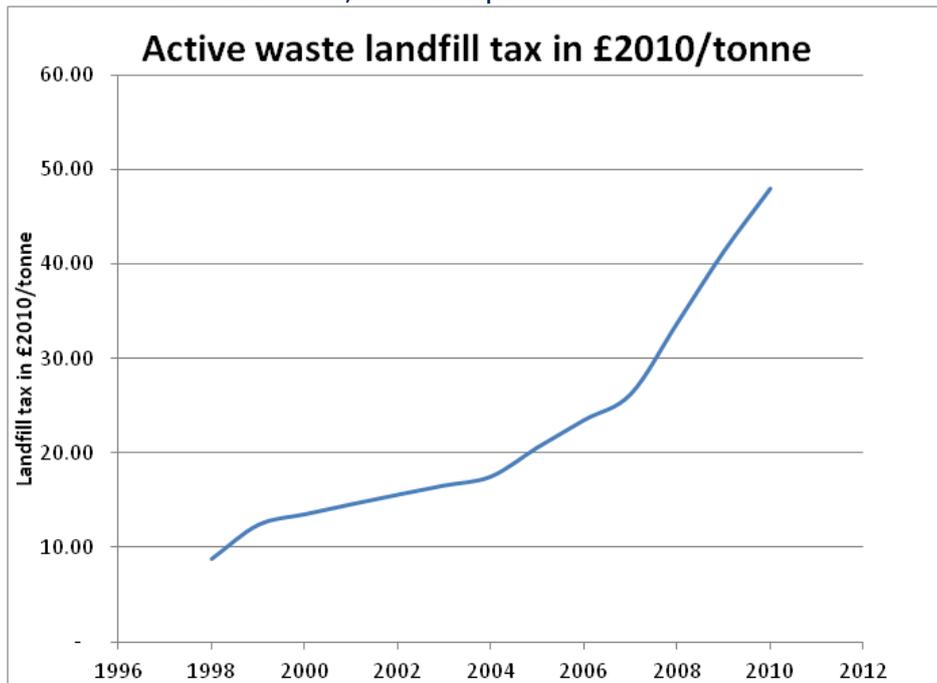
There is sufficient data for the household and municipal waste arising to use panel estimation, but not for C&D, Commerce or Industry waste streams.

## **Regression Results**

### **Household Waste**

A large number of regressions were estimated between levels of waste arising in the household sector and: population, household size, GDHI per capita, and GVA in various sectors. The regression also considers the effects of a landfill tax on domestic waste. The tax in real terms has risen considerably, as shown in [Figure 38](#). In 2010 pounds it has gone up from just under ten pounds per metric ton in 1998 to nearly 50 pounds in 2011. Since households do not pay the tax directly, its effects on waste arisings would be through local authorities' attempts to reduce waste.

**Figure 38** UK landfill tax 1998-2010, in £2010 per tonne



Source: HMRC (2012) Landfill Tax (LFT) Bulletin – February 2012

By including the variable in the fixed effects panel regression we assume implicitly that the tax is applied evenly across the UK rather than differently in the member nations of the UK. The results of the above regression with the landfill tax included are given below:

Dependent Variable: LOGHH  
 Method: Panel Least Squares  
 Date: 07/25/12 Time: 15:19  
 Sample (adjusted): 2001 2009  
 Periods included: 9  
 Cross-sections included: 4  
 Total panel (unbalanced) observations: 35  
 White diagonal standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.68460	0.705146	2.3890	0.02415
LOGGVA	0.31939	0.146115	2.1859	0.03767
LOGHHSIZE	-0.889167	0.299615	-2.9677	0.00622
LOGOTHSN	0.146785	0.059497	2.1671	0.02025
LF_A	-0.001518	0.000067	-22.7913	0.00000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.822396	Mean dependent var	2.714856
Adjusted R-squared	0.776351	S.D. dependent var	0.023765
S.E. of regression	0.011239	Akaike info criterion	-207.9433
Sum squared resid	0.003410	Schwarz criterion	-195.5005
Log likelihood	111.9717	Hannan-Quinn criter.	-203.6481
F-statistic	17.86054	Durbin-Watson stat	0.933463
Prob(F-statistic)	0.000000		

The following observations follow from this regression:

- a. The effect of a ten per cent increase in GVA per capita (in real terms) would result in a 3 per cent increase in Household waste per capita per year.
- b. A reduction in mean household size of approximately 10% (from 2.44 to 2.19 across the sample) would result in a 7.7 per cent increase in waste per capita.
- c. An increase in expenditure on other snacks and takeaway of ten per cent would increase waste arising by 1.5 per cent per capita.
- d. An increase in the landfill tax of ten per cent in real terms would reduce Household waste arisings by 0.02 percent.

In terms of diagnostics, the regression appears well determined and all explanatory variables are statistically significant. During the analysis of each individual variable, the other variables included in the regression are controlled.

The inclusion of the landfill tax makes some minor changes to the dummies for the UK nations, as shown in the table below:

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D_SCO	0.0351082	0.0101926	3.4445	0.00188
D_WAL	0.0532566	0.0205927	2.5862	0.01542
D_NIR	0.0946721	0.00876491	10.8013	<0,00001

As before, the above shows the dummy variables for the countries included, with England as the reference – that is, the coefficients show what the expected change in household waste would be for a household with other characteristics held constant would be in that nation (Scotland, Wales, Northern Ireland) compared to England. In each case the coefficients are positive, suggesting waste per household is lower in England than in Wales, Scotland or Northern Ireland when controlling for the other variables in the table. The coefficients are all significant at the 5% level and some are highly significant.

### **Conclusions**

The regression analysis confirms a strong relative decoupling of wastes with respect to GVA and also confirms that household size is important: the smaller the size the greater the waste per capita. Thirdly, the landfill tax is strongly correlated with household waste arisings and has a small but statistically significant effect on per capita waste. Dummies indicate that England has the lowest per capita household waste while the other UK nations all have higher levels.

Further data are needed to confirm these results and to better understand the factors that explain the different performance of the four UK nations.

# Appendix 5 UK nations waste policy targets

Table 7 summarises the policy targets set out in the UK nations' waste strategies.

**Table 7** Summary of policy targets across the UK nations

Target type	England	Scotland	Wales	Northern Ireland
<b>Waste prevention</b>			Waste reduction of around 27% of 2007 levels by 2025. This means that each year the waste production has to be reduced by 1.5% of 2007 levels.	
<b>Recycling</b>	From the Waste Strategy for England 2007: recycling and composting of household waste – at least 40% by 2010, 45% by 2015 and 50% by 2020	For all types of waste: 70% recycling by 2025.	All sectors will recycle at least 70% of their waste by 2025. The construction sector will be expected to reuse and recycle 90% of its wastes by 2025.	60% of Commercial and Industrial Waste to be recycled by 2020 75% of Construction, Demolition and Excavation Wastes to be recycled or reused by 2020 Reach recycling and composting of household wastes of 35% by 2010 ; 40% by 2015; 45% by 2020
<b>Landfilling</b>	From the Waste Strategy for England 2007: Increase diversion of household waste, to reduce amount not re-used, recycled or composted by 29% in 2010 and 45% in 2020.	For all types of waste: maximum 5% sent to landfill by 2025.	Residual waste will therefore be reduced to a maximum of 30%	Reduction of the annual tonnage of illegal waste disposed of to 1% of the 2004/05 baseline by 2015. Reduction of landfilled biodegradable municipal waste to: 75% of 1995 levels by 2010; 50% of 1995 levels by 2013; 35% of 1995 levels by 2020.
<b>Other</b>			Reduce the environmental footprint of waste to "one planet" levels by 2050, which means a reduction of around 65% compared to 2010 levels.	

## Appendix 6 Waste prevention measures

Table 8 covers measures for which there appears to be a lack of detailed evaluation.

**Table 8** Other measures

Measure	Evidence	Source
From Design to Disposal: A Common Approach With Business (UK)	Describes a number of measures to help businesses reduce waste but contains no evaluation of how they have worked.	Defra (2011c)
Buying standards for Government Departments for the procurement of food and catering	Discussed but not evaluated.	
Promotion of anaerobic digestion of food waste	Discussed but not evaluated.	
Landfill ban on certain kinds of waste (e.g. wood)	Discussed but not evaluated.	
Subsidy to finance R&D on material resource savings and on technologies that reduce waste	ERA-NET European project (SURPRISE) discussed but not evaluated.	Oakdene Hollins (2011)
Taxation of packaging, carrier bags, batteries	There is some evidence but it is mixed. In the case of plastic bags some countries report a big drop but also an increase in the sale of paper bags. A comprehensive assessment has not been carried out.	
'It's Smart with Less Waste' Helsinki, Finland): Best practice dissemination and information campaign and benchmarking tools in Helsinki	500 companies have joined the benchmarking program but no quantification of impact	EC (2012a and b)
Clever Akafen Ecolabel (Luxembourg): promotion of an ecolabel for Paints, rechargeable batteries and accessories, and low energy lamps and LED lamps	No quantification of impact	
Menu Dose Certa (Portugal): Awareness campaign to reduce food waste in restaurants	Too early to report any results	
Nemsitt.hu Construction Material Exchange (Hungary): An interactive online forum established to facilitate exchange of used construction materials	No quantification of results although the website is very active	
Carbon Tax on Packaging (Netherlands) introduced in 2008	Was expected to generate €365 million in 2009 but no confirmation, nor for the reduction in packaging.	
Stop Pub (France): awareness campaign including stickers to say no publicity	A high demand for stickers but no estimate of their impact	
Bricolage Design Prize (Australia): Promotion of eco-design to reduce waste	Number of companies have expressed interest but no estimate of impact in terms of waste	
Local Authority Prevention Demonstration Programme (Ireland): provides information on waste prevention techniques.	Started in 2006. No estimate of impacts available	

Measure	Evidence	Source
No disposables campaign (Korea): Targets fast food outlets through voluntary agreement initially and then legislation and a small levy on disposable items	No estimate of impacts available	
Swap-O-Rama-Rama (USA): Facilitates exchange of clothes through events where participants can exchange, donate and learn how to repair items	No estimate of impacts available	
Waste Cap (USA): performs waste audits, develops management plans and trains staff in waste reduction	No estimate of impacts available	
Earth Exchange (UK)	Website that facilitates the buying and selling of recycled or reusable materials directly from construction sites in the neighbourhood of the users. Diverted 81,000 tonnes of materials that would have otherwise gone to landfill from July 2008 to July 2009.	<a href="http://www.earthexchange.com/WantSoil.aspx">http://www.earthexchange.com/WantSoil.aspx</a> <a href="http://wastelines.wordpress.com/2009/07/28/earth-exchange-diverts-81000-tonnes-of-waste/">http://wastelines.wordpress.com/2009/07/28/earth-exchange-diverts-81000-tonnes-of-waste/</a>
Community RePaint (UK)	Network of paint recycling organisations which between them collected 450,000 litres of unwanted paint for reuse – worth £1.75 million – from householders and retailers in 2007.	<a href="http://www.communityrepaint.org.uk/about-us/">http://www.communityrepaint.org.uk/about-us/</a>
Deposit refund schemes for beverage containers (UK)	Regarding a pilot scheme in parts of rural England – an assessment shows that, although the system may increase return rates, the net present value of a DRS system is -£2,128m over the 2013-2017 period.	Defra (2011c)
Green tax on plastic shopping bags (UK)	Returns from a sample of shops showed food retailers were handing out up to 96% fewer bags, while home improvement retailers reported a 95% reduction, telecommunication retailers handed out 85% fewer bags, and fashion retailers reported a fall of up to 75% in the number of bags distributed.	<a href="http://www.greenwisebusiness.co.uk/news/uk-first-as-wales-introduces-green-tax-on-plastic-shopping-bags-2665.aspx">http://www.greenwisebusiness.co.uk/news/uk-first-as-wales-introduces-green-tax-on-plastic-shopping-bags-2665.aspx</a> <a href="http://www.businessgreen.com/bg/news/2189273/wales-plastic-bag-charge-yields-massive-green-savings">http://www.businessgreen.com/bg/news/2189273/wales-plastic-bag-charge-yields-massive-green-savings</a>
Take-back initiative for mercury thermometers (Austria)	Digital thermometer offered as a replacement for 1 Euro. Instead of the expected 50,000 mercury thermometers, 1 million thermometers were collected within only 15 working days. This is 50 % of the mercury thermometers estimated to have been in private stock at that time.	<a href="http://www.apotheker.or.at/Internet/OEAK/NewsPresse_1_0_0a.nsf/webPages/D4C2663E724C72CDC125724C003D0B19!OpenDocument">http://www.apotheker.or.at/Internet/OEAK/NewsPresse_1_0_0a.nsf/webPages/D4C2663E724C72CDC125724C003D0B19!OpenDocument</a> <a href="http://www.saubermacher.com/web/en/news/archive_details.php?nid=447">http://www.saubermacher.com/web/en/news/archive_details.php?nid=447</a> <a href="http://www.ots.at/presseaussendung/OTS_20071008_OTS0101/tag-der-apotheke-quecksilber-raus-aus-dem-haushalt-bild">http://www.ots.at/presseaussendung/OTS_20071008_OTS0101/tag-der-apotheke-quecksilber-raus-aus-dem-haushalt-bild</a>

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