

# Modelling the impact of lifestyle changes on household waste arisings

Defra Waste Research Evidence Programme Project (WR0107)

## Annex 4: Supplementary Model Validation Report December 2006

*This research was commissioned and funded by Defra. The views expressed reflect the research findings and the author's interpretation. The inclusion of or reference to any particular policy in this report should not be taken to imply that it has, or will be, endorsed by Defra.*



 **AEA**

future foundation  
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## Important Research Update (September 2009)

*The innovative input-output model (forecasting tool) that was constructed as a part of this research, was developed using the most up-to-date data on waste arisings available in 2005, at the project start, i.e. up to and including data for 2003/04. Following completion of the initial research and model development in July 2006, new data on waste arisings became available, which highlighted a divergence between the model predictions and reported data from 2002-2006.*

*Additional research indicated that it would be necessary to include a range of as-yet-not-understood factors within the model in order to develop more accurate predictions. Defra have commissioned further research to try to understand other factors that may have influenced changes in waste growth patterns. The Information Note published with this report gives more detail on this research and the background.*

*The divergence observed between the model forecasts and recent waste growth currently limits the application of the model for policy purposes, and means that caution should be used with respect to interpreting the figures contained in this report and the associated research documents (e.g. quantification of future waste tonnages). However, this project still allows exploration of future trends in waste composition, if not total quantity.*

## Introductory Note

The Defra Waste Resources Evidence Programme funded an innovative research project (WR0107) – “Modelling the Impact of Lifestyle Changes on Household Waste Arisings” that has resulted in the development of a forecasting tool to gain a better understanding of the composition of household waste and also how those arisings might grow in the future. The model takes into account the impact of economic, social and consumer trends on the composition and magnitude of household waste arisings to provide a range of alternative projections on the impact of different lifestyle trends on the future of household waste composition in England through to 2020. The model was designed to enable policy-makers to see the effect of probable trends in the main economic and social drivers on household waste arisings, such as increasing affluence and decreasing household occupancy levels. It also enables policy-makers to identify which sources of the waste stream are most sensitive to potential policy interventions and therefore provides evidence on which to prioritise and target policies.

The innovative input-output model (forecasting tool) that has been constructed was developed using the most up-to-date data on waste arisings available at that time. Following completion of the initial research and model development in July 2006, new data on waste have become available. Defra therefore commissioned additional work to investigate possible refinements to the model; in particular to investigate the short-term rates of growth in household waste (these have turned out to be rather lower than what the model would have predicted); at the same time, Defra wished to see if the model could be used to quantify the potential impacts of qualitative future waste scenario research being conducted in parallel (WR0104) – “Lifestyle Scenarios: Futures for Waste Composition”.

This Annex documents a specific element of the additional research (that was undertaken between July 2006 and August 2007) to answer the question: ‘If the model were to have been built in the year 2000, what levels of waste growth would it have forecast for the years that we now have reported statistics?’

The report follows the format of the presentation provided to a Defra Steering Group on 19<sup>th</sup> December 2006.

## Project objectives (1)

- Between July 2005 and July 2006 The Future Foundation, AEA Technology and The Social Marketing Practice carried out a project for Defra to construct models capable of explaining historical movements in household waste arisings in England
- We used this analysis and subsequent models to build a forecasting tool capable of producing forecasts for waste arisings to 2020, based on assumptions for the key drivers in the model
- The key ‘drivers’ of the models are a series of economic, demographic, social and lifestyle factors that have been discussed in detail over the course of the original project
- A ‘base’ case forecast was generated, essentially on the basis that the key drivers would continue to develop in a similar way to which they had over the past few years

## Project objectives (2)

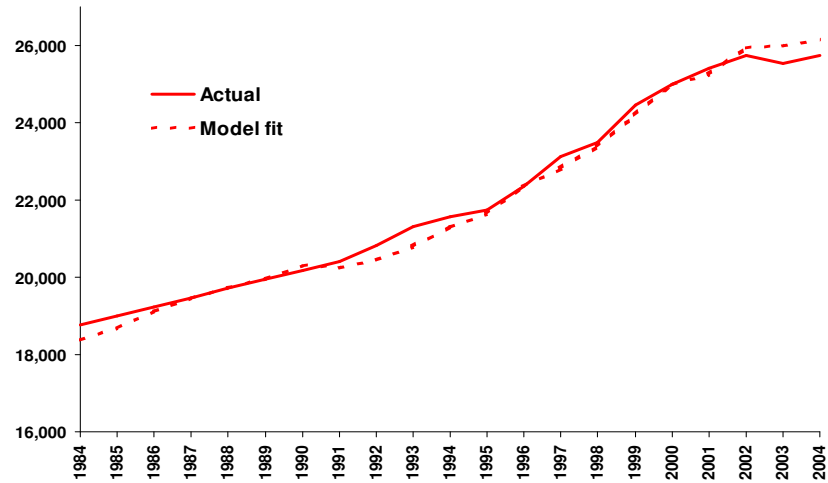
- Defra have asked whether it would be possible to validate the forecasting tool in order to provide greater reassurance in the projections of the models
- We have therefore carried out a 'retrospective forecast' asking the question ..... 'if we were currently in 2000 and had data up to 1999, what forecasts would we have produced for the years 2000 – 2004
- This presentation looks at the results of this analysis, particularly in light of the Defra data published for household waste arisings in 2005/06

## The original model

- In building our original model a key objective was to produce relationships that predicted total waste arisings to be as close as possible to what was actually reported (particularly from the mid 1990s when the official data apparently became more reliable)
- For the period 1995 – 2004 although the average error of the model was close to zero it did actually over predict for years 2002 – 2004
- In our model building we had made the assumption that this 'over prediction' was not due to a fundamental change in the relationships described within the model, but a result of 'one off' factors e.g dry summers reducing the amount of garden waste etc

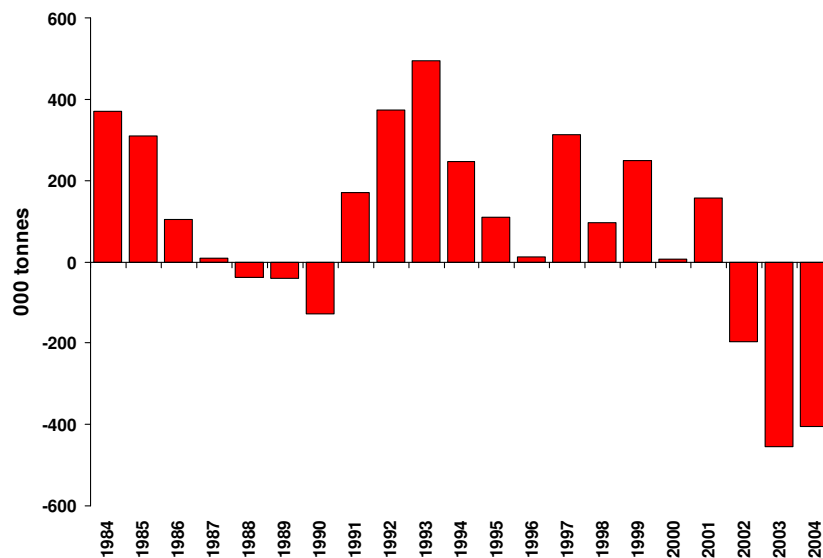
## Household Waste Arisings in England (000s tonnes)

Model fit



## Household Waste Arisings in England (000s tonnes)

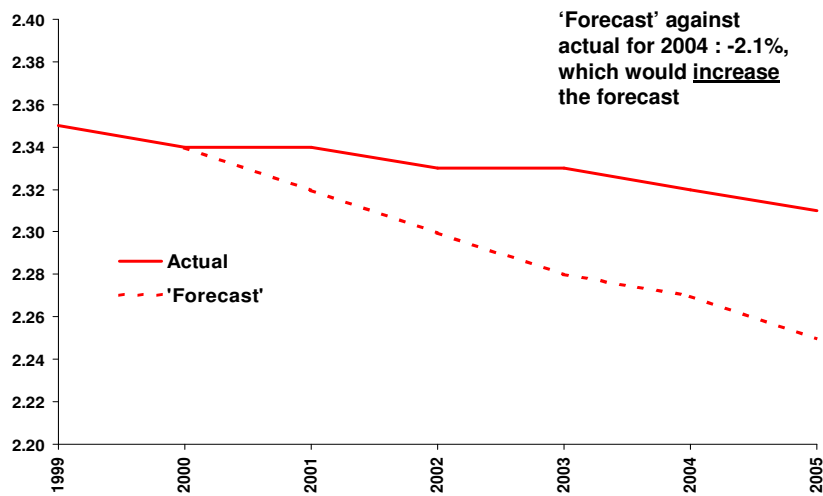
Model error (actual – fitted)



## A 'forecast' made in 2000 (1)

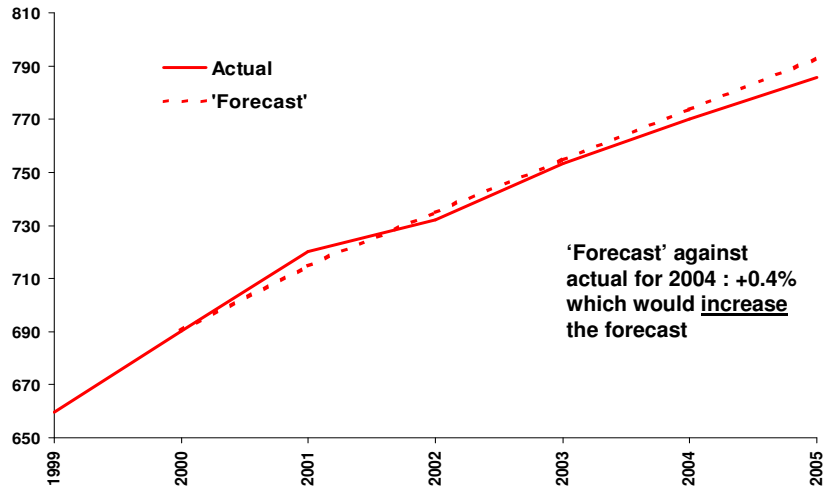
- Generally there are two sources of forecast error :
  - A change in the nature of the behavioural relationships described by the model
  - Incorrect assumptions for the model 'drivers'
- In order to re create a forecast that might have been made in 2000 we have :
  - Re estimated the underlying components of the waste model, using data only up to 1999
  - Generated forecasts for waste 2000 – 2004 using these re estimated models along with assumptions for the drivers that we would have made in 2000 (using either historical Future Foundation forecasts, government forecasts and where appropriate a continuation of trends in the drivers which had occurred historically e.g the circulation of free newspapers)
- We can then compare these 'forecasts' with the actual outcome as reported by Defra

## 'Forecast' of average hh size\* against actual outturn (persons/hh)



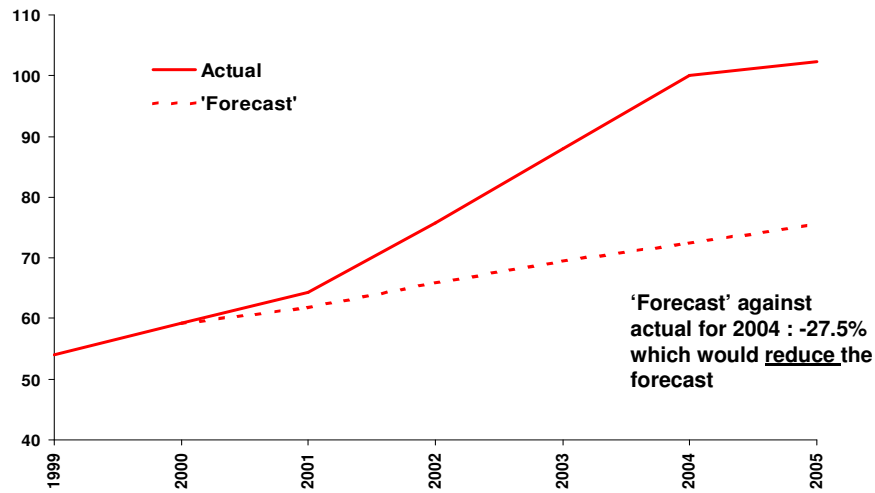
\* Extrapolation of historical trend

**'Forecast' of RHDI\* against actual outturn  
(£bn)**



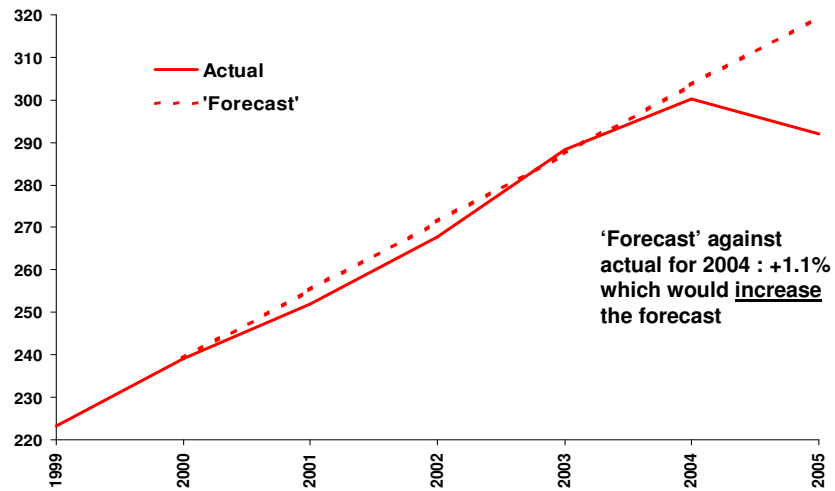
\* Future Foundation forecast July 2000

**'Forecast' of property prices\* against actual outturn  
(Real price index, 2004=100)**



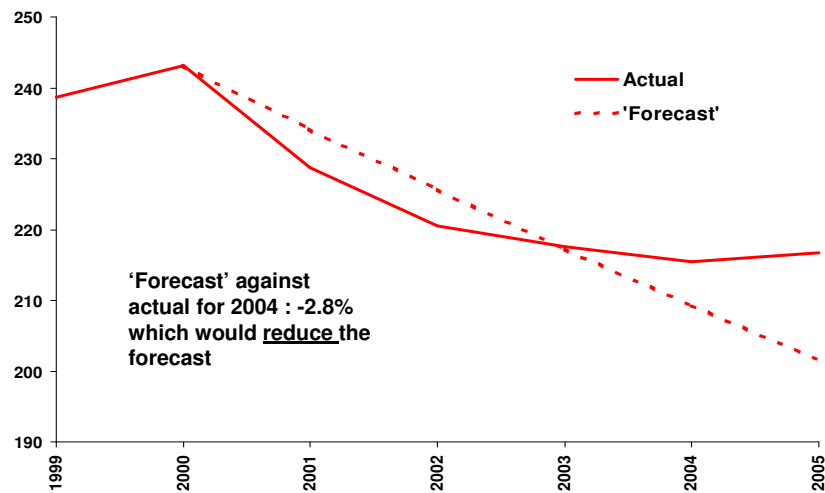
\* Future Foundation forecast July 2000

### 'Forecast' of direct mail against actual outturn (000 tonnes)



\* Extrapolation of historical trend

### 'Forecast' of free newspapers against actual outturn (£000 tonnes)

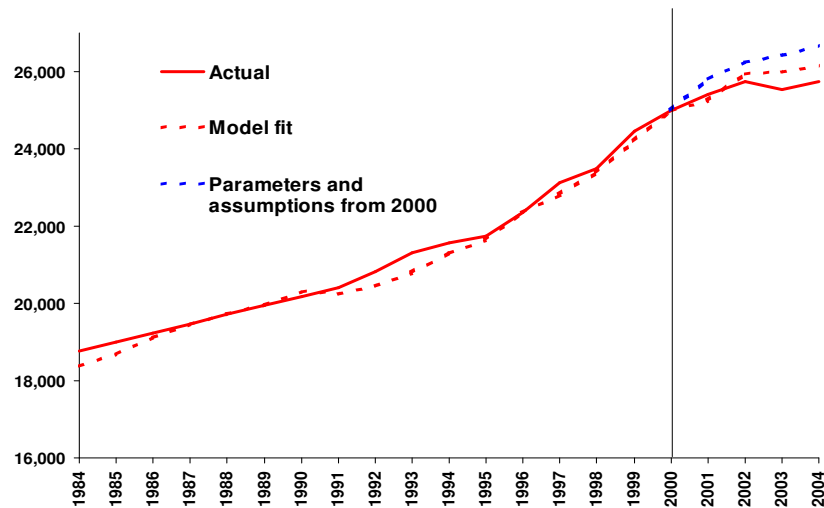


\* Extrapolation of historical trend

## A 'forecast' made in 2000 (2)

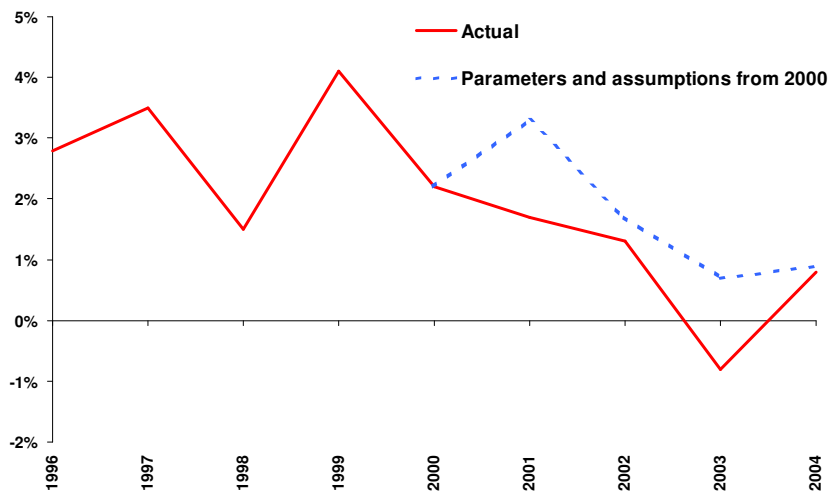
- The 'forecast' made in 2000 based on the re-estimated model and the assumptions we would have made at that time are above both the actual and the levels fitted in the estimation process

## Household Waste Arisings in England (000s tonnes) Alternative 'forecasts'





## Household Waste Arisings in England (% pa) Alternative 'forecasts'



### A 'forecast' made in 2000 (2)

- The 'forecast' made in 2000 based on the re-estimated model and the assumptions we would have made at that time are above both the actual and the levels fitted in the estimation process
- For 2004 while our model fit is 2.4% above the actual (as reported by Defra) the 'forecast that would have been made in 2000 is 3.6% above the actual – equating to 926,000 tonnes

### Model fit and '2000 forecast' compared to Actual %difference from actual

	Model fit	Model parameters 1980 - 2000, assumptions made in 2000
2000	0.0%	0.0%
2001	-0.6%	1.6%
2002	0.8%	2.0%
2003	1.8%	3.5%
2004	2.4%	3.6%

### Model fit and '2000 forecast' compared to Actual 000 tonnes from actual

	Model fit	Model parameters 1980 - 2000, assumptions made in 2000
2000	-7.5	-7.5
2001	-157.9	412.5
2002	196.1	513.9
2003	455.4	899.9
2004	605.8	925.7

## **A 'forecast' made in 2000 (2)**

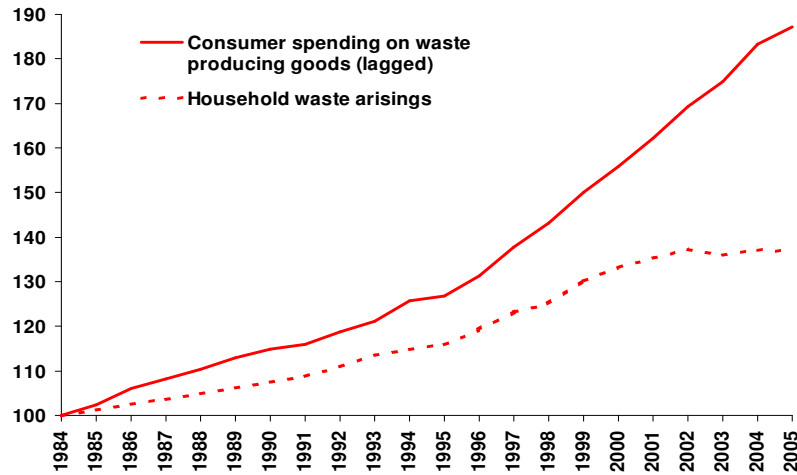
- The 'forecast' made in 2000 based on the re-estimated model and the assumptions we would have made at that time are above both the actual and the levels fitted in the estimation process
- For 2004 while our model fit is 2.4% above the actual (as reported by Defra) the 'forecast that would have been made in 2000 is 2.35 above the actual – equating to 926,000 tonnes
- So, while the reported data suggests that by 2004 waste arisings had grown by 3.0% compared to the position in 2000, our 'forecast' made in 2000 would have suggested an increase of 6.7% (i.e. actual growth of 0.7%pa compared to a 'forecast' of 1.6%pa)

## **2005/06 data (1)**

- Data for the 2005/06 financial year has now been published by Defra, which shows a further small fall in waste arisings for England
- Using this data to estimate calendar year figures suggests that for calendar 2005 there was a 0.4% fall in waste arisings
- Given our 'over forecasts' for the years 2001 – 2004 we were expecting a reasonably significant increase in waste arisings for 2005
- A fall in waste is not consistent with the predictions of the model
- Or, in more general terms, it is not consistent with the growth in consumer spending on waste generating goods

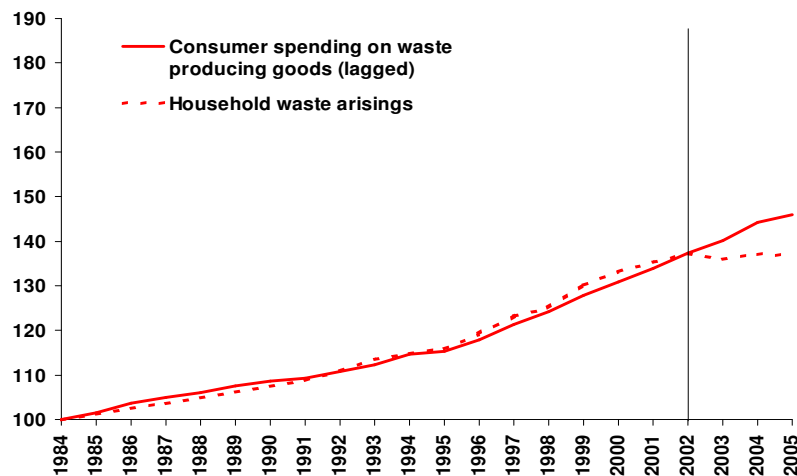
### Household Waste Arisings in England and consumer spending on waste producing goods

Index 1984=100



### Household Waste Arisings in England and consumer spending on waste producing goods (at 60% of actual)

Index 1984=100



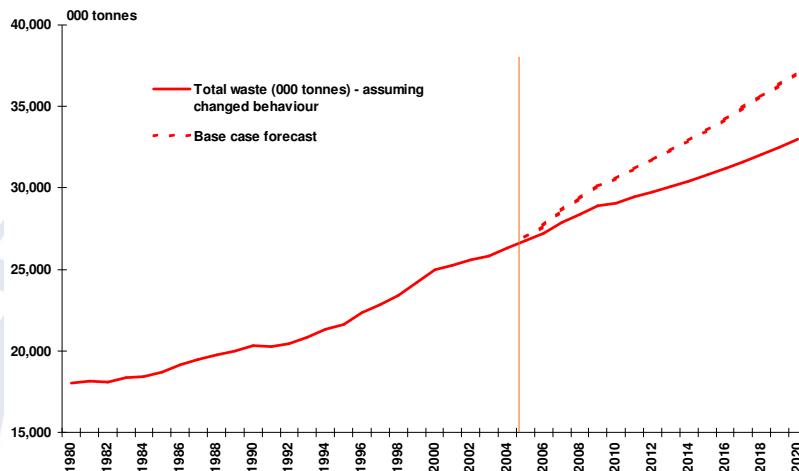
## 2005/06 data (2)

- The mismatch in 'actual' against 'predicted' over the past three years is either a result of :
  1. Official figures not properly reflecting actual behaviour
    - Waste moving from hh sector to other sectors
    - LADs changing the way they record the data
  2. Behaviour described within the model actually having changed over the past few years
- Within the model we have assumed (as there is no evidence available to do otherwise) that the trends over the past three years have either remained unchanged or have continued to follow the trend of the last 10 years

## 2005/06 data (3)

- Factors that might have changed would include :
  - Products becoming lighter (per £ of expenditure)
  - A marked acceleration in the improvement in quality of product purchased (which would reduce the weight of product per 'constant' £ of expenditure)
  - Less of the product ending up as waste (particularly important for food)
  - Less of the waste produced entering the waste stream
  - The average weight of packaging per kg of product falling
  - Products being kept for longer and so not entering the waste stream as quickly
- There is little reason though to believe that any of these factors would have changed radically in such a short space of time
- We have created a new forecast though assuming that less of the product ends up as waste. In our base case we had assumed a small increase in the amount of waste (only really relevant for food) while in this new forecast we have assumed quite a drastic reduction on waste (which still fails to explain much of the 'over forecast' of the last three years)

## Base case forecast compared to a forecast assuming 'changed' behaviour



## Summary (1)

- While our original model did, in construction, over predict waste arisings for 2002 – 04, over the period for which we thought that we have reasonably reliable data (1995 – 2004) the average error of the model was close to zero
- Simulating a forecast that might have been made in 2000 (on the basis of building models using data to 1999) we would again have over predicted waste arisings for the years 2000 – 2004
- However, our 'forecast' for 2004 (i.e five years from 'creation') would have only been 3.6% above actual

## Summary (2)

- Data has now been published for 2005/06, which has allowed us to estimate waste arisings for calendar year 2005
- This suggests a further divergence from the model
- This divergence is either due to :
  - Official figures not properly reflecting actual behaviour
  - Behaviour described within the model actually having changed over the past few years
- We think that the former is probably the primary cause, as consumer behaviour is unlikely to have changed as rapidly as would be needed in such a short period of time