



Moderating the distributional impacts of personal carbon trading

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1 EXECUTIVE SUMMARY

In 2008, the Centre for Sustainable Energy (CSE) completed an analysis of the likely distributional impacts of Personal Carbon Trading (PCT) in the UK, on behalf of Defra¹. The study modelled an equal per adult carbon allowance allocation system using three years of the ONS Expenditure and Food Survey (EFS, 2003 - 2006). The analysis showed that despite the overall progressiveness of an equal per adult carbon allowance allocation system a significant number of low income households would be made worse off by PCT.

As part of its ongoing investigation into PCT, the Institute for Public Policy Research (IPPR) therefore commissioned CSE to explore the potential for moderating the negative impacts of a personal carbon allowance system on low income households.

The study presented here explores two potential and distinct approaches for impact mitigation, both of which are modelled on the 2003 – 2006 EFS dataset developed in CSE's previous work for Defra¹. The first approach explores the potential to modify the way in which allowances are allocated, such that this is not simply on an equal per adult basis. The second approach explores the potential to financially compensate low income households under a range of carbon price scenarios.

Impact mitigation through modified allowance allocation

This approach attempts to reduce the negative impact of PCT on low income households by designing and applying a set of modification 'rules' to the allocation of allowances. Through CSE's previous work for Defra, key household characteristics related to whether a household 'won' or 'lost' – i.e. whether the household would have a surplus or deficit of allowances – were identified through regression analysis. The regression model identified a relationship between a wide range of socio-demographic variables contained in the EFS dataset and household allowance surplus/deficit with a 50% fit ($R^2 = 0.51$). The output of the regression model is a regression equation - a linear equation that predicts household allowance surplus/deficit for any combination of values for all the variables used in the model.

The aim of modifying the allocation of allowances is to provide additional allowances for factors that increase the likelihood that a household will experience a deficit in allowances. To avoid favouring choice-based carbon-intensive behaviour, however, only those factors considered 'structural', rather than 'life-style', are included in modified allocation system. In addition, the following criteria were also applied when identifying factors for inclusion in the modified carbon allowance allocation rules:

- i. Information on any selected factor should be practically obtainable and verifiable by the operator of a UK PCT system;
- ii. Selection should be based on factors beyond the short-term control of individuals;
- iii. It must be possible to analyse the effect of each factor on carbon allowance surplus/deficit using the EFS-based dataset created by CSE for the Defra study¹.

Based on the criteria above and previous analysis by CSE of the relationship between household allowance surplus/deficit and socio-demographic variables in the EFS¹, the following factors were selected for inclusion in the modified allowance allocation rules:

- Number of children
- Rurality
- Age of HRP
- Built form
- Central heating type

The regression equation derived from CSE’s previous work¹ is used to model the effect on household allowance surplus/deficit of each of these factors. By holding all variables in the regression equation constant and altering the value of only one of the above listed factors at a time (e.g. increasing the number of children from one to two), the effect on household surplus/deficit of that variable is determined. This equates to the size of the allowance (in kg CO₂) allocated under the modified allowance allocation rules for that specific value.

This process was undertaken for each value of the factors selected for inclusion in the rules, under two allocation scenarios: the first where the modified allocation rules were applied to ‘low income’ households only; and the second where all households in the EFS dataset were included in the modified allocation.

A total of 4.4 million households are both identified as ‘low income’ (using benefits status information in the EFS) and qualify for allowances under the modified rules. This rises to 17 million when the rules are applied to all households in the EFS dataset.

Having distributed extra allowances according to the modified allocation rules under the two scenarios, the remaining allowances are distributed equally to all households on a per-adult basis. The total quantity of remaining allowances is equal to the total household carbon emissions for the EFS dataset, minus what has already been allocated under the modified allocation rules.

The impact of the modified allocation rules on the mean allowance distributed equally to all adults is shown in below, alongside the original equal per adult allocation modelled in CSE’s previous work¹. This shows that under a universal equal per adult allocation, all adults receive 4.4tCO₂, but this is reduced to 4.3t and 3.8t when the modified allocation rules are applied under the two scenarios respectively.

Table A: Impact on the residual equal per adult allowance of the three allocation scenarios

| Mean equal per adult allowance (kg CO₂): | |
|-------------------------------------------------------------------|-------|
| Equal per adult allocation | 4,423 |
| Modified allocation rules applied to ‘low income’ households only | 4,321 |
| Modified allocation rules applied to all households | 3,837 |

The distributional impacts of applying the modified allocation rules to 'low income' households only and to all households are considered in terms of:

- i. Overall impact on the proportion of 'winners' and 'losers'
- ii. Impact on low income households
- iii. Impact on the existing household clusters (created through CHAID analysis in CSE's previous work)

Results are compared with those drawn from CSE's previous analysis of an equal per adult allowance allocation¹.

A household is considered to be 'losing' if it experiences a deficit in carbon allowances; that is, household emissions are greater than the total allowance allocated to the household. All other households are considered as 'winners' (whether they have a substantial surplus in allowances, or just break even).

When the modified allocation rules are applied to low income households only, this has very little effect on the overall proportion of winners and losers, compared with a universal equal per adult allocation. The total proportion of losers increases by just 0.4% (from 41.2% to 41.6%). The impact on households in income deciles 1 to 3 is slightly more prominent, with a decrease in the proportion of losers by 1.9% (29% to 27.1%). However, there are still some two million households in these lower deciles that experience a deficit in allowances and 1.1 million of these are not in receipt of the specified state benefits. This highlights the complexity of identifying low income households through the benefits system- there is inevitably a mismatch which limits the extent to which the impact of PCT on low income households can be mitigated.

Applying the modified allocation rules to all households increases the overall proportion of losers in the EFS dataset, compared to an equal per adult allocation, by 3% (from 41.2% to 44.1%). The proportion of losers in income deciles 1-3 also increases, by 1.2%. However, whilst there are a greater proportion of low income households losing, the extent of the deficit experienced decreases: the lowest three income deciles are actually better off overall with a higher net surplus than under an equal per adult allocation.

Analysis of the mean surplus/deficit in allowances by socio-demographic variables under the three allowance allocation scenarios shows that:

- Household characteristics that demonstrated a strong association with allowance deficit under an equal per adult allowance allocation – namely, detached households, households with oil central heating, households with children and households in rural areas- are significantly better off when the modified allocation rules applied to all households; (applying these rules to low income households only has little impact).
- When applied to all households, the modified allocation rules have little effect on the mean surplus/deficit by: benefits status; income decile; tenure; economic position of HRP; number of vehicles; and age of HRP.

The modified allocation rules applied to all households do, therefore, appear to reduce the impact of ‘structural’ factors on a household’s allowance balance, consequently reducing the variance of surplus/deficit, without disproportionately impacting on any particular income group.

Investigation of the distribution of ‘winning’ and ‘losing’ household clusters created in CSE’s work for Defra using CHAID, (for full details of how these clusters were created please refer to the project report¹) shows a similarly encouraging result. Applying the modified allowance allocation rules to all households creates a more even distribution of cluster surplus/deficit. (Applying the rules to ‘low income’ households only has little impact). The clusters of extreme winners and losers are no longer evident under the modified rules; there are no groups experiencing a deficit of over 10,000 kg, when there were previously three under an equal per adult allocation. Furthermore, there are some notable shifts from ‘losing’ to ‘winning’ by several low income, potentially vulnerable clusters.

Impact mitigation through financial compensation

The second approach to impact mitigation of PCT explores the potential for financial compensation. The aim of this approach is to provide a monetary sum to ‘low income’ households to reflect the cost of any carbon allowance deficit that is or may be experienced, thereby providing financial means to cope with that deficit (either through purchasing additional allowances or investing in carbon reduction measures).

The cost of providing this financial compensation to households identified as ‘low income’ (again identified using benefits status information contained in the EFS dataset) is explored under four scenarios, using a range of different carbon prices. The four scenarios relate to whether only ‘low income’ losing households are awarded financial compensation for the exact value of their allowance deficit under each of the allowance allocation scenarios modelled, versus whether all ‘low income’ households are awarded financial compensation regardless of whether they experience a deficit in allowances under a PCT system. In the latter case, the cost of providing compensation at the mean and median level of household deficit for all ‘low income’ losing households is explored. These scenarios are summarised below.

Table B: Financial compensation scenarios

| Compensation scenario | HH known to be in deficit? | Proxy measure of low income status using EFS household benefits information | Level of financial compensation |
|------------------------------|-----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| Compensation scenario 1: | Yes | In receipt of housing benefit, council tax benefit, income support, job-seekers allowance (income-based) or pension credit. | Equal to exact household allowance deficit under each of the three allocation scenarios |
| Compensation scenario 2: | Yes | In receipt of housing benefit, council tax benefit, income support, job-seekers allowance (income-based), pension credit or the State pension | Equal to exact household allowance deficit under each of the three allocation scenarios |
| Compensation scenario 3: | No | Households in receipt of housing benefit, council tax benefit, income | Equal to mean <i>(or median)</i> allowance deficit for ‘low income’ |

| | | | |
|--------------------------|----|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| | | support, job-seekers allowance (income-based) or pension credit. | group under each of the three allocation scenarios |
| Compensation scenario 4: | No | In receipt of housing benefit, council tax benefit, income support, job-seekers allowance (income-based), pension credit or the State pension. | Equal to mean (<i>or median</i>) allowance deficit for 'low income' group under each of the three allocation scenarios |

In addition to the four compensation scenarios described above, five carbon price scenarios are applied, where the cost per tonne of CO₂ varies as follows: a) £15/tonne; b) £25/tonne; c) £35/tonne; d) £40/tonne; e) £50/tonne.

These compensation and carbon price scenarios are combined and applied under each of the three carbon allowance allocation scenarios (equal per adult allocation; modified allocation rules applied to 'low income households'; and modified allocation rules applied to all households).

When all households identified as 'low income' (using benefits status information in the EFS) and suffering a deficit in allowances are financially compensated for the exact value of their deficit, the total cost is between £72 and £315 million, depending on the initial carbon allowance allocation system (which determines the extent of allowance deficit) and the price per tonne of carbon applied (compensation scenario 1, table B). These households receive an average of £51 to £195 in compensation (but there will be significant variation around this mean).

If all 'losing' pensioner households are also financially compensated, in addition to those identified as 'low income' through benefits status, the total cost rises to between £215 and £810 million, again depending on the initial allowance allocation system and the price per tonne of carbon applied (compensation scenario 2, table C).

The total cost of financially compensating all households identified as 'low income', regardless of whether they experience an allowance deficit or not, ranges from £286m to £1.1bn (depending on the carbon price and the allowance allocation scenario which determines the mean value allocated, compensation scenario 3 in table C). When households in receipt of the State pension are included (compensation scenario 4 in table C) the total cost rises to £607m to £2.4bn. Applying the carbon prices to the median value of allowance deficit of all 'low income' households reduces the total cost of compensation scenarios 3 & 4 by around a half.

Conclusions

Building on previous research, this report has explored the potential to mitigate the negative impacts of personal carbon trading on low income households, through two distinct approaches.

The first approach applied a set of modified allowance allocation rules, the aim being to provide allowances for household characteristics that have been shown to increase the likelihood that a household will suffer a deficit in allowances. This approach appears to be successful. Whilst the overall

proportion of 'losing' households in the EFS dataset increased slightly, the impact of 'structural' factors on household allowance balance was reduced, reducing the spread of surplus/deficit, without impacting on any particular income group or 'lifestyle' factor. By reducing the extent of deficit suffered by 'losing' households, this effectively increases the likelihood that the household may be able to avoid deficit through behavioural change and no/low cost measures to cut emissions.

The second approach modelled a system of financial compensation for 'low income' households. The results of the modelling showed that the costs of doing so vary considerably depending on: how 'low income' households are defined and identified (i.e. whether all State pensioners are included); whether these households are compensated only if they are 'losing', for the exact value of their deficit, or if all identified 'low income' households are given financial compensation, regardless of household allowance balance; whether, in the case of the latter scenario, a mean or median value of deficit is applied to determine the level of compensation received; and finally the price per tonne of carbon applied. Providing financial compensation to 'low income' losing households for the exact value of their allowance deficit costs considerably less than providing compensation to all 'low income' households, regardless of household allowance balance. However, in practice the former scenario may suffer drawbacks, as it would (1) be information intensive, and (2) could lead to perverse incentives to increase emissions.

On the whole, however, a personal carbon allowance allocation system is progressive, even without any financial compensation to 'low income' households. Modelling on the EFS dataset has shown that around 70% of income deciles 1, 2 and 3 experience a surplus of allowances under all allowance allocation scenarios modelled.

This research also provided opportunity to explore the potential for successfully identifying low income households through the benefits system, as the EFS dataset used for the modelling contains both actual household income and benefits status at a household level. This showed that 28% of the lowest income decile were not claiming any of the five key income-related benefits available in the EFS household dataset (council tax benefit, income support, housing benefits, job-seekers allowance and pension credit). This rises to 39% for income decile 2, and 64% for income decile 3. Including all households in receipt of the State Pension in the proxy measure reduces these figures to 18%, 14% and 28% respectively.

Combining the results of the carbon allowance allocation modelling and benefits/income analysis shows that 15% of the lowest three income deciles in the EFS dataset, and 10% of the lowest decile, experience a deficit in allowances under all allocation systems modelled and are not in receipt of benefits. This suggests around 250,000 of the poorest 10% of households (and 1 million of the poorest 30%) may be at risk from suffering a deficit in carbon allowances under the PCT systems modelled here and be difficult to identify and target with compensatory measures.

2 INTRODUCTION

In 2008, the Centre for Sustainable Energy (CSE) completed an analysis of the likely distributional impacts of Personal Carbon Trading (PCT) in the UK, on behalf of Defra¹. The study modelled an equal per adult allowance allocation system using three years of the ONS Expenditure and Food Survey (EFS, 2003 - 2006). It showed that despite its overall progressiveness, a significant number of low income households would be made worse off by PCT, if allowances were allocated on this equal per adult basis.

As part of its ongoing investigation into PCT, the Institute for Public Policy Research (IPPR) therefore commissioned CSE to explore the potential for moderating these impacts of a personal carbon allowance system on vulnerable, low income households.

The study explores two potential and distinct approaches for impact mitigation, both of which use the 2003 – 2006 EFS dataset developed in CSE's previous work for Defra.

The first approach designs and tests a set of 'modifications' to the way PCT allowances are allocated. Through CSE previous work for Defra key household characteristics that determined whether a household 'won' or 'lost' – i.e. whether the household would have a surplus or deficit of allowances – were identified.

From these, factors that were strongly associated with a household experiencing a deficit in allowances and that may be considered structural (i.e. non 'lifestyle' choice) were selected for inclusion in the modified allowance allocation. This approach allowed the development of a set of rules that allocate additional allowances for specific household characteristics, thereby modulating the social distribution of the impacts of PCT without rewarding carbon intense behaviour.

The impact on all and in particular low income households, of applying these modified allowance allocation rules is assessed. For context, the results are compared with the equal per adult allowance allocation modelled in CSE's previous.

The second impact mitigation approach investigates the potential for financially compensating low income households. The level of financial compensation is set according the mean and median level of allowance deficit of all low income 'losing' households. The overall costs of doing so are explored, under a range of carbon price scenarios.

Both approaches at some stage require the identification of 'low income' households. Whilst actual household income is provided in the EFS dataset, in practice such information is unlikely to be readily available. Therefore benefits status information provided in the EFS dataset is used a 'proxy' measure for low income. The correlation between this proxy measure and actual household income is explored.

3 APPROACH 1: IMPACT MITIGATION THROUGH MODIFIED ALLOWANCE ALLOCATION

This section explores the potential for mitigating the negative impacts of personal carbon trading on low income households through a set of modified allowance allocation rules. The rules are applied under two scenarios: the first being to 'low income' households only; and the second to all households regardless of income. 'Low income' households are identified using information on benefits status contained in the Expenditure and Food Survey.

The process for modelling this mitigation approach is as follows:

1. Identify low income status using household benefits information in the EFS
2. Identify factors to be included in the modified allowance allocation rules
3. Model the size of and allocate these additional allowances under two scenarios: (1) to 'low income' households only; and (2) to all households
4. Assess the impact of the reallocation on the distribution of household allowance surplus/deficit.

3.1 IDENTIFYING LOW INCOME HOUSEHOLDS

For the purposes of scenario one of the modified allowance allocation rules, 'low income' households are defined as those in receipt of any of the following income-related state benefits, which are included in the EFS household dataset: council tax benefit; housing benefit; income support; job-seekers allowance (income-based); pension credit. Whilst actual household income data is also contained in the EFS, this information would not be readily available in practice for administering a PCT system, hence benefits information is used as a proxy measure for income status.

Information contained in the EFS (2003 – 2006) shows that nearly a quarter (23%) of all households are in receipt of one or other of the above named benefits. These households are therefore the only ones to receive any additional allowances under the first scenario of modified allocation rules.

3.2 ALLOCATING ALLOWANCES UNDER THE MODIFIED ALLOCATION RULES

3.2.1 Identifying factors for inclusion in the modified allocation

Regression analysis undertaken in CSE's previous PCT work for Defra¹ identified key factors related to household allowance deficit. The aim of modifying the allocation of carbon allowances is to provide additional allowances to compensate for the negative impact of these factors. However, to avoid favouring a choice-based carbon-intensive lifestyle, only those factors considered 'structural', rather than 'life-style', are included in modified allocation system. In addition, the following criteria were also applied when selecting factors for inclusion in the modified carbon allowance allocation rules:

- iv. Information on any selected factor should be practically obtainable and verifiable by the operator of a UK PCT system;

- v. Selection should be based on factors beyond the short-term control of individuals;
- vi. It must be possible to analyse the effect of each factor on carbon allowance surplus/deficit using the EFS-based dataset created by CSE for the Defra study¹.

The regression model developed in CSE previous PCT work identified a relationship between household allowance surplus/deficit and a range of socio-demographic variables, shown in Table 1. All of these variables are contained in the EFS dataset. The output of the regression model is a regression equation - a linear equation that predicts, with a 50% fit ($R^2 = 0.51$), the surplus/deficit of allowances for any combination of values of the factors listed in Table 1.

Table 1: Factors affecting household surplus/deficit as identified by the regression model

| | | |
|---------------------------------------------------------|--------------------|----------------------------|
| • number of children | • built form | • central heating type |
| • rurality | • number of adults | • number of vehicles |
| • age of household reference person (HRP ⁱ) | • tenure | • economic position of HRP |
| • number of household appliances | • number of rooms | • equivalised income |
| • Government Office Region | | |

Based on the criteria set out above and previous analysis by CSE of the relationship between household allowance surplus/deficit and socio-demographic variables in the EFS¹, the following factors were selected for inclusion in the modified allowance allocation rules:

Table 2: Factors selected for inclusion in the modified allowance allocation rules

| |
|------------------------|
| • Number of children |
| • Rurality |
| • Age of HRP |
| • Built form |
| • Central heating type |

3.2.2 Calculating the size of allowances under the modified allocation rules

Each of these variables takes on of a range of values that describe the characteristics of a household. For example, the value for number of children in a household may be none, one, two, or three or more; the built form of a household may be 'detached', 'semi-detached', 'terrace' or 'flat', and so on.

The aim of the modified allocation rules is to provide carbon allowances to counteract the potential negative impact of the factors listed in Table 2. The regression equation is used to determine which values of these factors qualify for allowances and how much the allowance should be.

ⁱ HRP is the Household Reference Person. "The HRP is the person who: owns the household accommodation, or is legally responsible for the rent of the accommodation, or has the household accommodation as an emolument or perquisite, or has the household accommodation by virtue of some relationship to the owner who is not a member of the household. If there are joint householders the HRP will be the one with the higher income. If the income is the same, then the eldest householder is taken. (EFS, 2005-2006, Volume 1, User Guide).

By altering the value in the regression equation of only one of the factors selected for inclusion in the modified rules at a time (e.g. increasing the number of children from one to two), the effect on household surplus/deficit of that variable is determined. This effect equates to the size (in kg CO₂) of the allowance allocated for that particular factor value under the modified allowance rulesⁱⁱ.

This process was undertaken for each value of the factors selected for inclusion in the modified allocation rules under the two allocation scenarios ('low income' households only and all households).

3.2.3 Allocating allowances under the modified allocation rules

The total number of households receiving allowances under the modified allocation rules, and the sum of the allowances distributed are shown in Table 3 below. This shows that when the modified allocation rules are applied to 'low income' households only, a total of 4.4 million households qualify for allowances, whereas when applied to all households, this rises to 17 million.

Table 3: Total households receiving allowances and sum of allowances under modified allocation rules

| Modified allowance allocation scenario | Total households receiving allowances under modified rules (thousands) | Sum of allowances (tCO ₂) |
|----------------------------------------|------------------------------------------------------------------------|---------------------------------------|
| 'Low income' households only | 4,445 | 4,601 |
| All households | 17,300 | 26,430 |

Having distributed allowances according to the modified allocation rules under the two scenarios, the remaining 'pot' of allowances - equal to the total household carbon emissions for the EFS dataset minus what has already been allocated under the modified allocation rules - is then distributed equally on a per adult basis.

The impact of applying the modified allowance allocation rules on this residual mean allowance distributed equally to all adults is shown below, alongside the original equal per adult allocation.

Table 4: Impact on the residual equal per adult allowance of the three allocation scenarios

| Mean equal per adult allowance (kg CO ₂): | |
|-------------------------------------------------------------------|-------|
| Equal per adult allocation | 4,423 |
| Modified allocation rules applied to 'low income' households only | 4,321 |
| Modified allocation rules applied to all households | 3,837 |

As the figures above show, the impact on the equal per adult allowance of applying the modified allocation rules to 'low income' households is fairly minimal, reducing this by approximately 100kg. This is because of the limited number of households actually qualifying for additional allowances under this

ⁱⁱ Further research could be undertaken to explore the impact of interaction effects by changing more than one factor in the regression equation at a time (for example if a household has three or more children and lives in a detached house the value of the additional allowance would be different to when these factors vary individually).

scenario (Table 3): when the benefits status and structural requirements of the modified allocation rules are combined in this scenario, less than one fifth of all households actually qualify for these allowances, amounting to just over 2% of the total carbon allowance 'pot'. Applying the allocation rules to all households, not just those considered 'low income', however, sees over 17 million households (70% of all households) receive allowances (accounting for around 13% of the total allowance pot) and as such the impact on the equal per adult residual allowance is greater, reducing this to 3.8t.

3.3 THE IMPACT OF THE MODIFIED ALLOCATION RULES

The distributional impacts of applying the modified allocation rules to 'low income' households only and to all households are considered in terms of:

- iv. Overall impact on the proportion of 'winners' and 'losers'
- v. Impact on low income households
- vi. Impact on the existing household clusters (created through CHAID analysis in CSE's previous work¹)

3.3.1 OVERALL IMPACT: 'WINNERS' AND 'LOSERS'

A household is considered to be 'losing' if it experiences a deficit in carbon allowances; that is, household emissions are greater than the total allowance allocated to the household. All other households are considered as 'winners' (whether they have a substantial surplus in allowances, or just 'break even').

Table 5 below shows that if the modified allocation rules are applied to low income households only, this has very little effect on the overall proportion of winners and losers, when compared with an equal per adult allocation. The total proportion of losers increases by just 0.4% (from 41.2% to 41.6%). The impact on households in income deciles 1 to 3 is slightly more prominent, with a decrease in the proportion of losers by 1.9% (29% to 27.1%). The proportion of households with a deficit of more than 4 tonnes shifts slightly towards the upper income deciles under this allocation scenario.

Applying the modified allocation rules to all households increases the overall proportion of losers, compared to an equal per adult allocation, by 3% (from 41.2% to 44.1%). The proportion of losers in income deciles 1-3 now increases, by 1.2%. However, whilst there are a greater proportion of low income households losing, the extent of the deficit experienced has decreased: 7.6% of households in income deciles 1 to 3 experience a deficit of more than 4tCO₂, compared to 8.7% under an equal per adult allocation.

Table 5: Impact of modified allowance allocation rules on proportion of winners and losers by income decile group

| Income deciles (equivalised) | | <i>Equal per adult allocation</i> | Modified allocation rules: 'Low income' HHs | Modified allocation rules: All HHs |
|------------------------------|------------------------|-----------------------------------|---------------------------------------------|------------------------------------|
| 1 to 3 | % Losers | 29.0% | 27.1% | 30.2% |
| | Losing by more than 4t | 8.7% | 7.8% | 7.6% |
| 4 to 7 | % Losers | 40.0% | 41.3% | 42.9% |
| | Losing by more than 4t | 13.7% | 14.0% | 13.3% |
| 8 to 10 | % Losers | 55.0% | 56.6% | 59.5% |
| | Losing by more than 4t | 24.7% | 25.5% | 25.9% |
| Total | % Losers | 41.2% | 41.6% | 44.1% |
| | Losing by more than 4t | 15.5% | 15.6% | 15.4% |

Table 6 shows the impact of the modified allowance allocation on the proportion of winners and losers by benefits status. Under all allocation scenarios, at least two thirds of households claiming one or more of the listed benefits (and/or the state pension) experience a surplus of allowances. Where low income households are targeted with the modified allocation rules, this proportion increases to 76%; whereas when the modified allowance rules are applied to all households, regardless of income, the proportion of winning households on benefits decreases to 69%.

Table 6: Winners and losers by benefits status

| Benefit claimant | | Equal per adult allocation | | Modified allocation rules: 'Low income' HHs | | Modified allocation rules: All HHs | |
|------------------------------------------|------------|----------------------------|------------|---------------------------------------------|------------|------------------------------------|------------|
| | | Deficit | Surplus | Deficit | Surplus | Deficit | Surplus |
| CT/ IS/ HB/ JSA/ PCⁱⁱⁱ | No | 45% | 55% | 47% | 53% | 48% | 52% |
| | Yes | 29% | 71% | 24% | 76% | 31% | 69% |
| CT/ IS/ HB/ JSA/ PC/ Pension | No | 47% | 53% | 49% | 51% | 51% | 49% |
| | Yes | 33% | 67% | 32% | 68% | 35% | 65% |

Figure 1 shows the proportion of winners and losers by income decile and benefits status in the EFS dataset for each of the allowance allocation scenarios. This shows that approximately 30% of households in income decile 1 experience a deficit in allowances (under all allocation scenarios) and around one third of these (10% of the decile overall) are not in receipt of benefits. Similarly, around 28% of households in income decile 2 experience a deficit and 13% of the decile are in deficit and not on benefits. Table 1 in the Annex shows a detailed breakdown of these figures, which are summarised in Table 7 below. This shows that of the some 30% of households losing (under all three allocation scenarios) in income deciles 1 to 3, half are not in receipt of state benefits. Therefore, whilst targeting low income households with additional allowances using the benefits system does reduce the overall proportion of households in the lowest three income deciles experiencing a deficit (Table 5), there are still some two million households in these lowest three deciles that experience a deficit in allowances and 1.1 million of these are not in receipt of the specified state benefits. This highlights the success/failure rate of targeting low income households through the benefits system which limits the

ⁱⁱⁱ CT – council tax benefit; IS – Income support; HB – Housing Benefit; JSA – Job seekers allowance; PC – Pension credit

extent to which the impact of PCT on low income households can be mitigated. This is discussed further in section 4.

Table 7: Proportion of households in deficit by income decile group and benefits status

| Income decile group & benefits status | | | Scenario 1 - Equal per adult allocation | Scenario 2 –Allocation rules low income HHs | Scenario 3 – Allocation rules all HHs |
|---------------------------------------|----------------|-----|-----------------------------------------|---------------------------------------------|---------------------------------------|
| CT/ IS/ HB/ JSA/ PC | Deciles 1 - 3 | No | 15% | 15% | 15% |
| | | Yes | 14% | 12% | 15% |
| | Deciles 4 - 7 | No | 36% | 38% | 39% |
| | | Yes | 4% | 3% | 4% |
| | Deciles 8 - 10 | No | 53% | 54% | 57% |
| | | Yes | 2% | 2% | 3% |
| CT/ IS/ HB/ JSA/ PC/ State Pension | Deciles 1 - 3 | No | 7% | 7% | 7% |
| | | Yes | 22% | 20% | 23% |
| | Deciles 4 - 7 | No | 26% | 28% | 28% |
| | | Yes | 14% | 14% | 15% |
| | Deciles 8 - 10 | No | 46% | 47% | 50% |
| | | Yes | 9% | 9% | 10% |

Figure 1: Winners and losers by income decile and benefits status

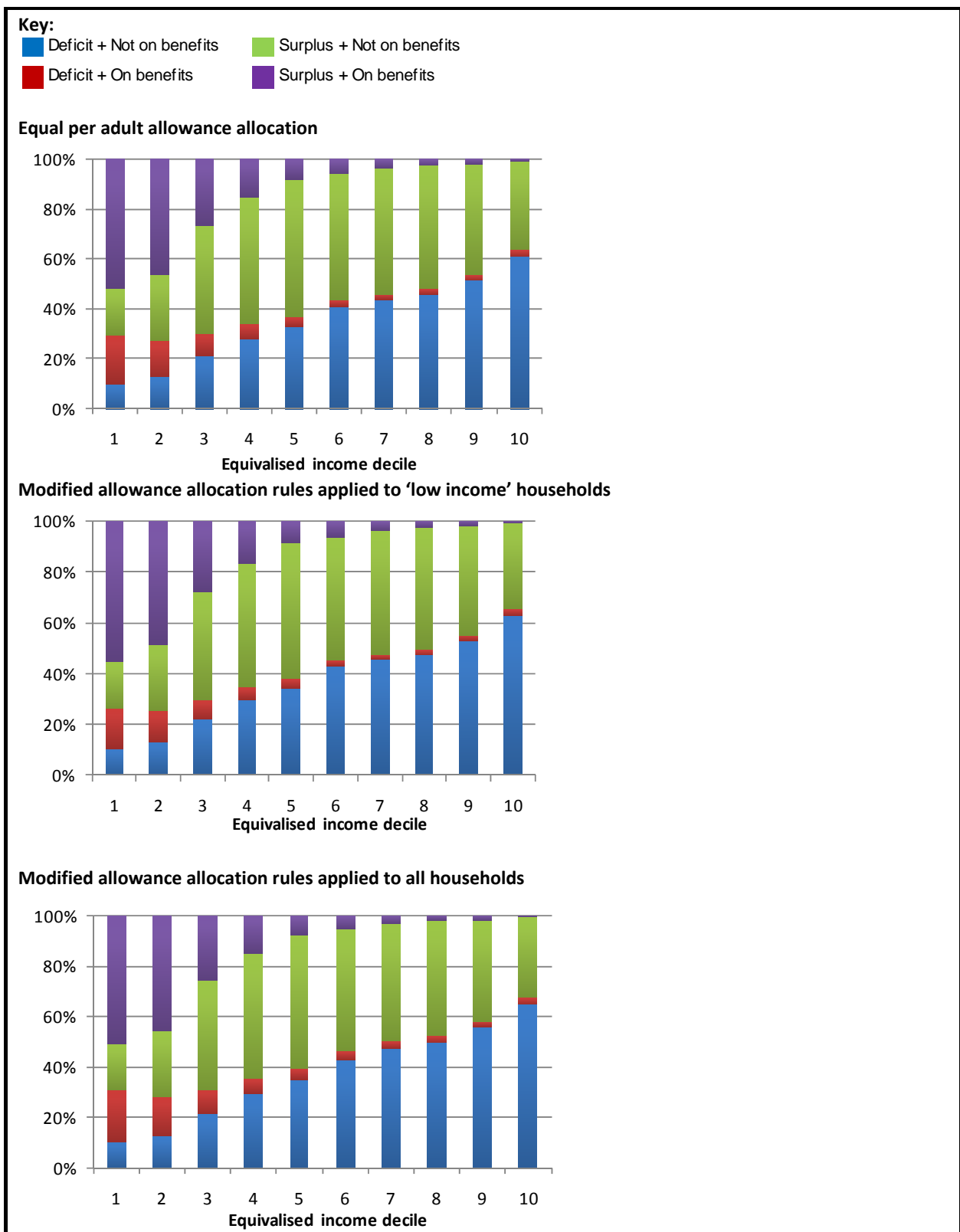


Table 8 shows the net surplus/deficit of allowances under each scenario for the three income groups. It shows that when the modified allocation rules are applied to all households, the lowest three income deciles are actually better off overall with a higher net surplus than under an equal per adult allocation. The middle four deciles are little affected in terms of net surplus/deficit and the top three income deciles experience a slightly higher overall net deficit. Applying the modified allocation rules to 'low income' households only sees the lowest three income deciles experience an even greater net surplus, but this then impacts more significantly on all the remaining decile groups.

Table 8: Household net surplus/deficit by income decile group (tCO₂)

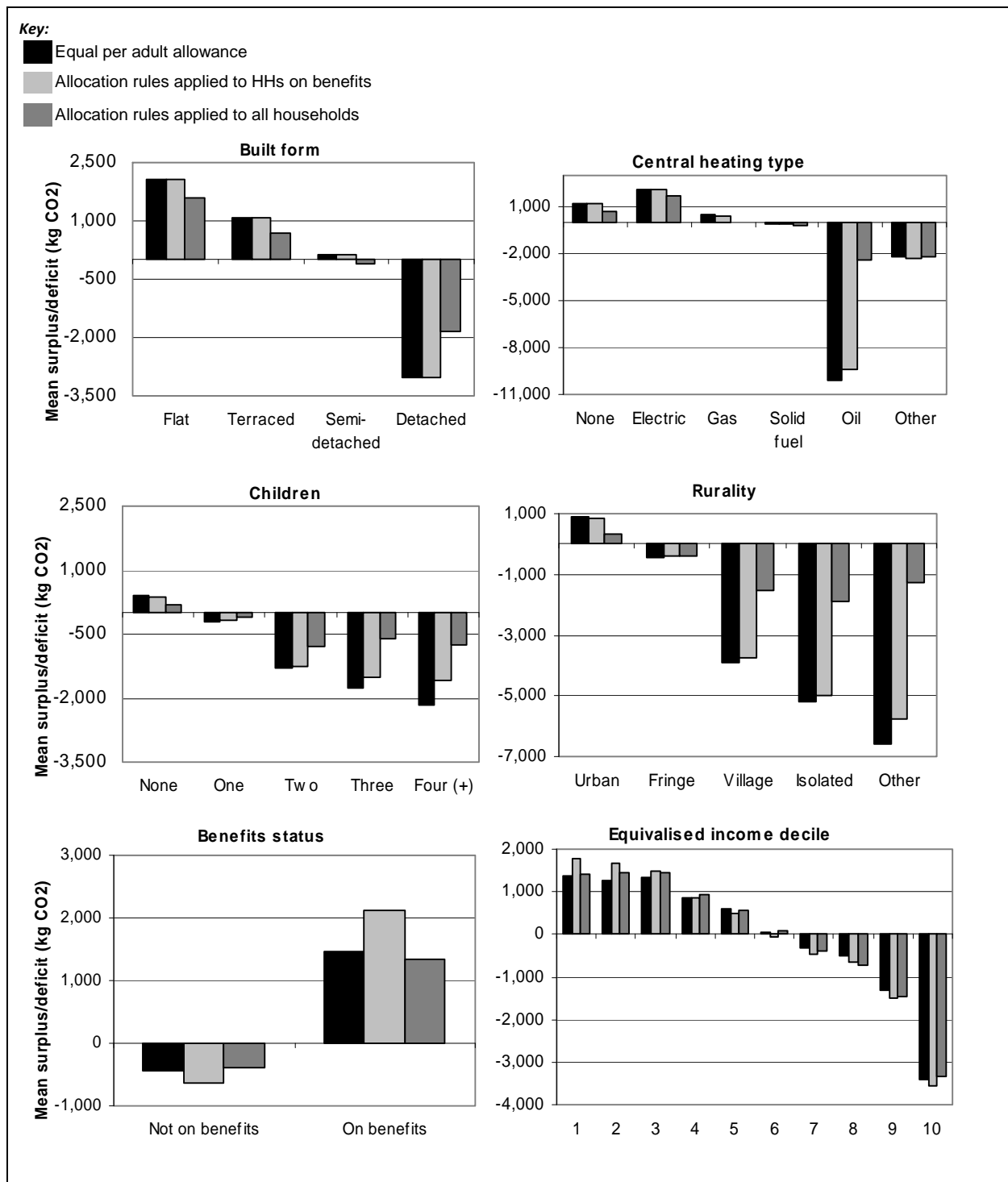
| Income deciles (equivalised) | Equal per adult allocation | Modified allocation rules: 'Low income' HHs | Modified allocation rules: All HHs |
|------------------------------|----------------------------|---------------------------------------------|------------------------------------|
| 1 to 3 | 9,832 | 12,069 | 10,550 |
| 4 to 7 | 2,986 | 2,016 | 2,981 |
| 8 to 10 | -12,818 | -14,085 | -13,531 |

The mean surplus/deficit in allowances by socio-demographic variables under the three allowance allocation scenarios is shown in Figure 2 (note that the scale of the y-axis is necessarily different for each graph). The black shaded bar shows the equal per adult allocation; the light grey shows the modified allocation rules applied to low income households only; and the dark grey bar shows the modified allocation rules applied to all households. This shows that:

- Household characteristics that demonstrated a strong association with allowance deficit under an equal per adult allowance allocation – namely, detached households, households with oil central heating, households with children and households in rural areas- are significantly better off when the modified allocation rules applied to all households; (applying these rules to low income households only has little impact).
- The modified allocation rules have little effect on the mean surplus/deficit by: benefits status; income decile; tenure; economic position of HRP; number of vehicles; and age of HRP when applied to all households.
- Households with more than three adults were notable 'winners' under the equal per adult allocation; such households are still winning, but by significantly less under the modified allocation rules.
- Large houses (by number of rooms) are losing by less under the modified allowance allocation rules (likely due to the link between number of rooms and built form, the latter of which is included under the rules).

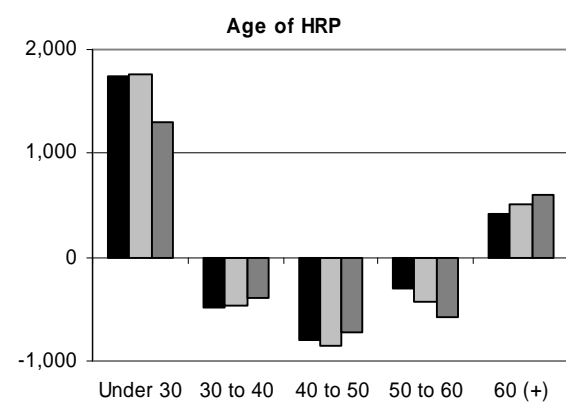
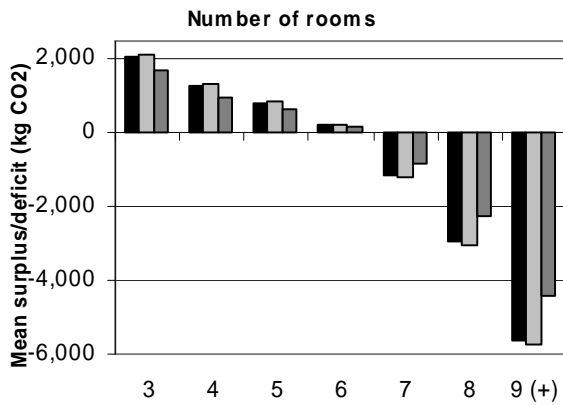
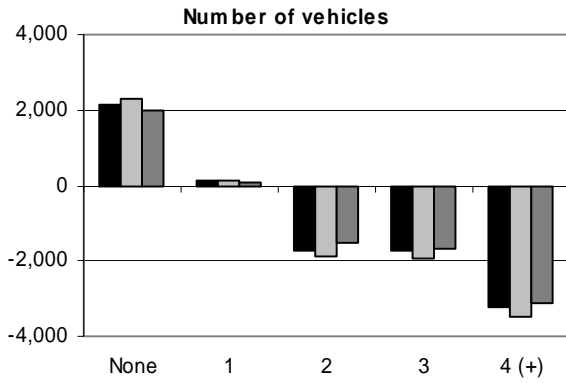
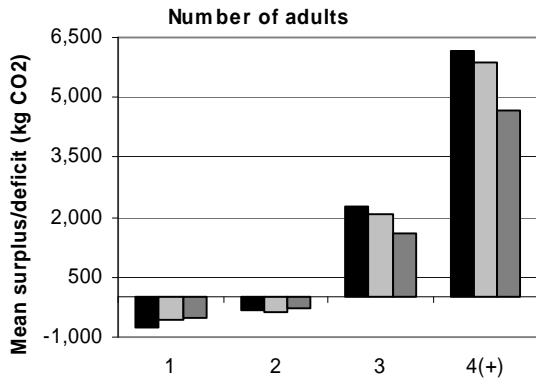
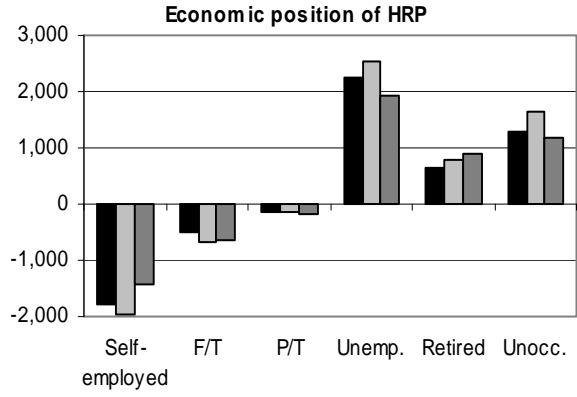
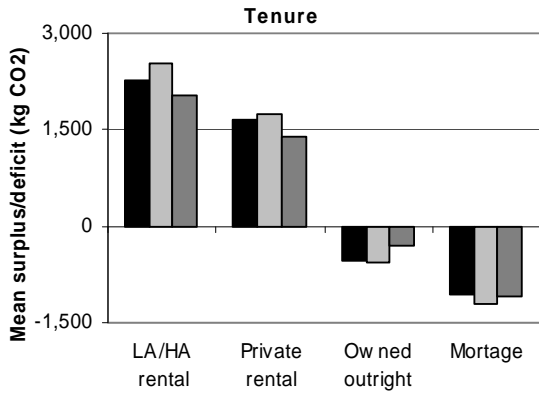
The modified allocation rules applied to all households do, therefore, on the whole, appear to reduce the impact of 'structural' factors on a household's allowance balance, hence reducing the overall variance in surplus/deficit across households, without impacting disproportionately on any particular income group.

Figure 2: Mean surplus/ deficit by socio-demographic variables



Key:

- Equal per adult allowance
- Allocation rules applied to HHs on benefits
- Allocation rules applied to all households



3.3.2 IMPACT OF MODIFIED ALLOCATION RULES ON HOUSEHOLD CLUSTERS

Investigation of ‘winners’ and ‘losers’ by the household clusters created in CSE’s work for Defra is shown below. (For full details of how these clusters were created please refer to the project report¹).

Figures 3 to 5 show histograms of the distribution of household clusters under the three different allowance allocation scenarios. Figure 6 and Figure 7 compare these distributions side-by-side and overlaid, respectively. The x-axis shows the mean allowance surplus/deficit of each cluster in kgCO₂. Under an equal per adult allocation clusters of households with very high average allowance surpluses and deficits were identified (Figure 3). shows that the application of the modified allowance rules to low income households only has limited impact on this distribution of winning and losing groups.

Applying the modified allowance allocation rules to all households, however, does demonstrate a shift to a more even cluster distribution (Figure 5). Clusters of extreme winners and losers are no longer evident; there are no groups experiencing a deficit of over 10,000 kg, when there were previously three. This is an encouraging result. Further investigation of clusters under this allocation scenario reveals some notable success stories, as discussed below.

Table 9 shows the key socio-economic characteristics of the household clusters, ordered by mean allowance surplus/deficit under the modified allocation rules applied to all households. As applying the modified rules to ‘low income’ households only has a limited impact on the household clusters - several low income groups are winning by more or losing by less (i.e. are better off) than under an equal per adult allocation, but there are still notable extremes and no low income clusters are lifted out of deficit - this scenario has not been included in the table and the discussion below focuses only on the impact of the modified allowance allocation rules applied to all households compared to an equal per adult allocation.

Clusters that were losing under the equal per adult allocation system are shaded grey in Table 9; all clusters that suffer a deficit under the modified allocation rules applied to all households are shown below the red line. The difference in the group mean surplus/deficit in allowances (kg CO₂) between these two allocation scenarios is also shown: figures in red show where a cluster is made worse off under the modified allocation system. These clusters are referred to and described further in the discussion below.

Figure 3: Distribution of household clusters: Equal per adult allowance allocation

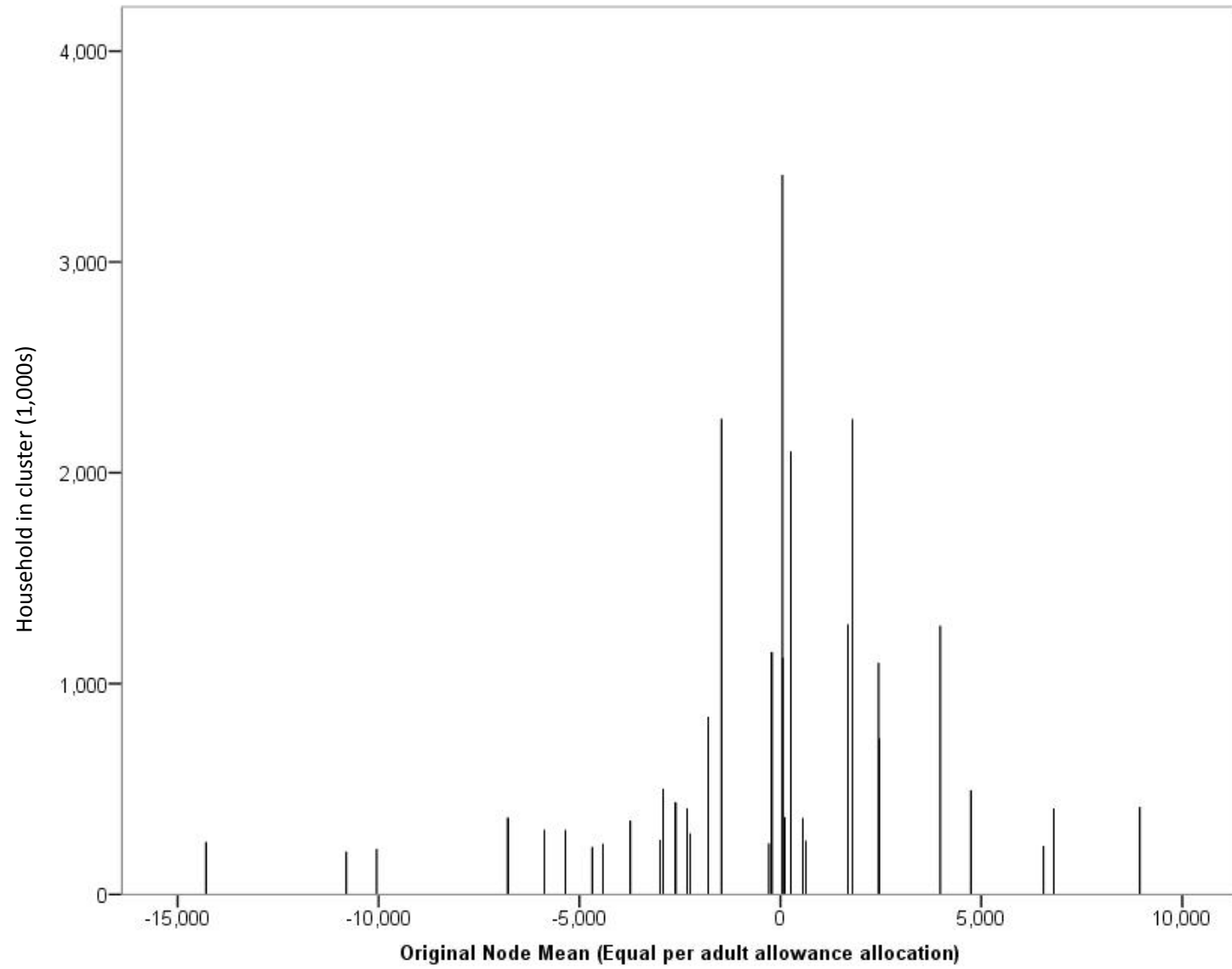


Figure 4: Distribution of household clusters: Modified allowance allocation rules applied to low income households only

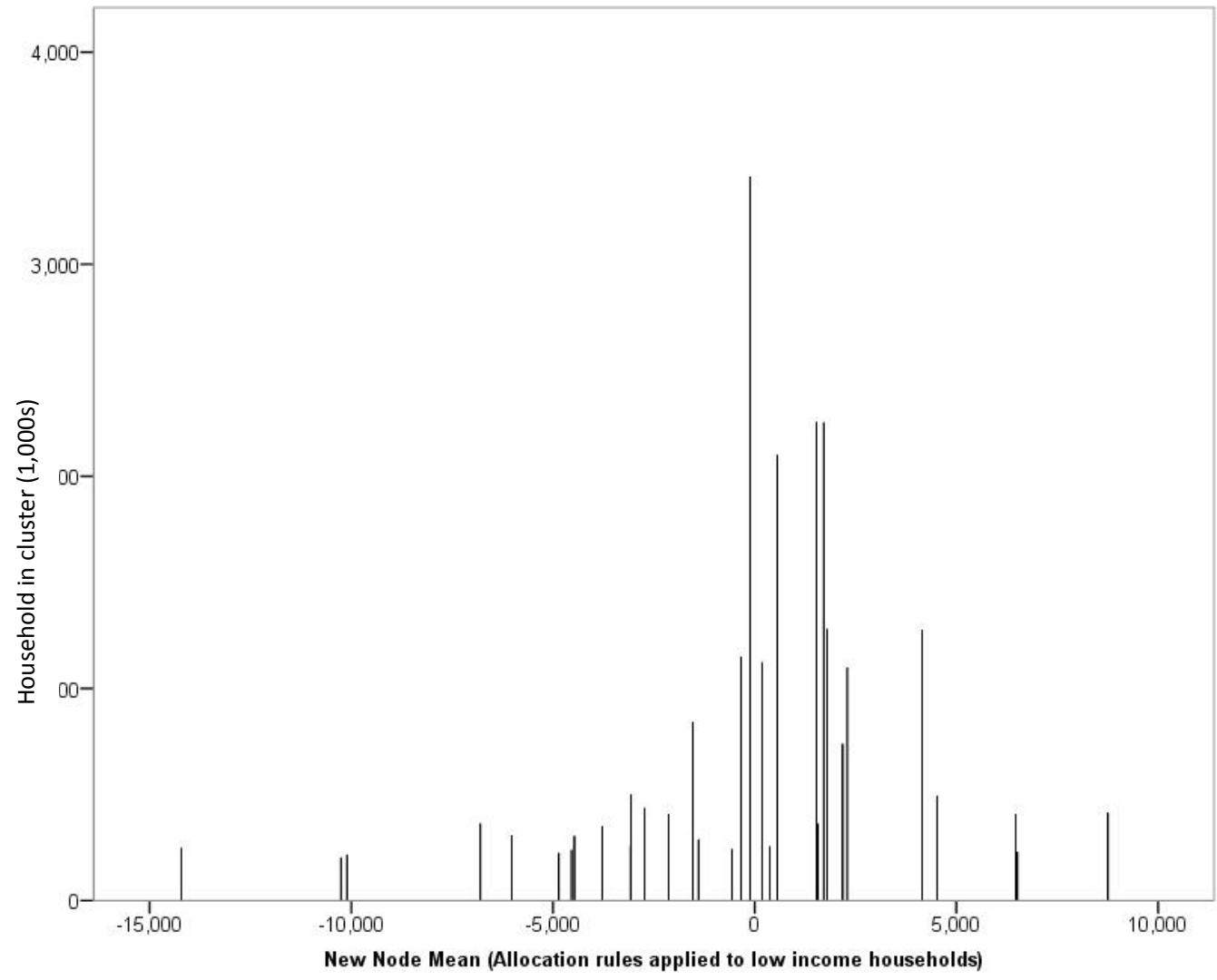


Figure 5: Distribution of household clusters: Modified allowance allocation rules applied to all households

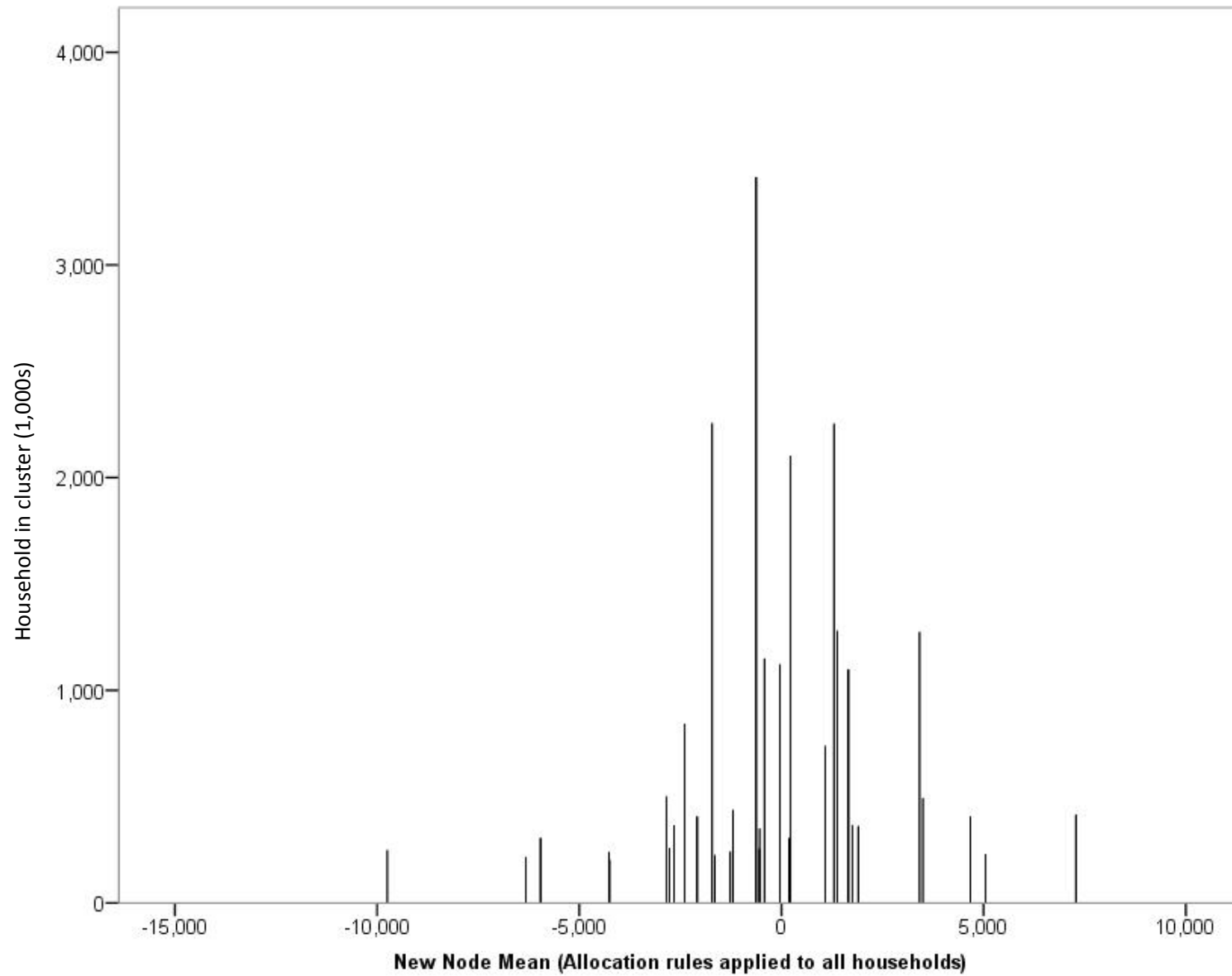
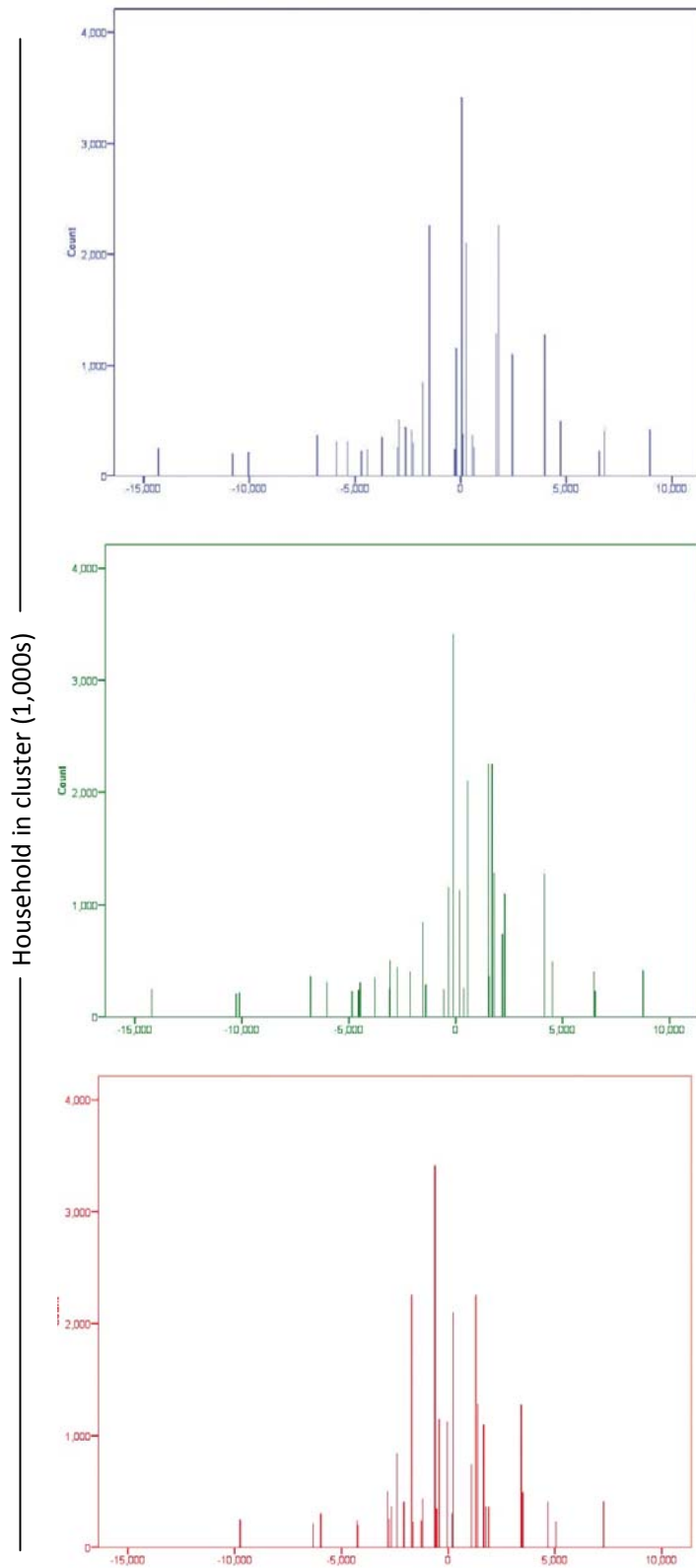


Figure 6: Comparison of cluster distributions under the three allowance allocation scenarios



(1) Equal per Adult Allowances

(2) Modified allocation rules applied to low income households only

(3) Modified allocation rules applied to all households

Figure 7: All three distributions overlaid

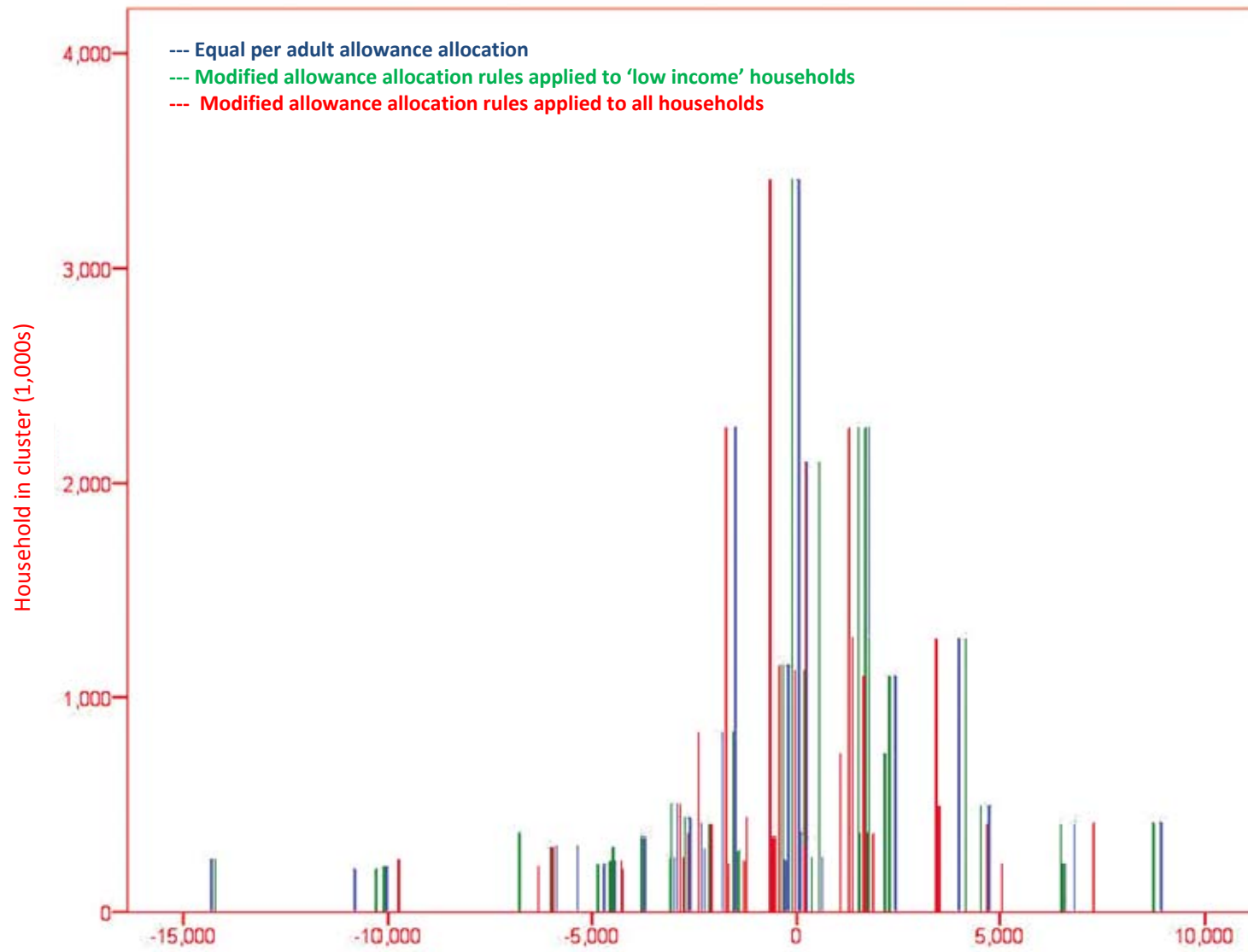


Table 9: Dominant characteristics of all household clusters (grey shading = groups losing under equal per adult allocation; below red line = groups losing under modified allocation rules applied to all households)

| Group | # HHs (1000's) | % of UK HHs | % HHs in income decile 1-3 | Surplus/Deficit <i>Equal per adult</i> | Surplus/Deficit <i>Modified</i> | Difference in surplus/deficit | Income tendency | Mean Adults | Mean Children | Predominant Rurality | Predominant Housing Type | Predominant Tenure | Mean no. rooms | |
|---------|----------------|-------------|----------------------------|----------------------------------------|---------------------------------|-------------------------------|-----------------|-------------|---------------|----------------------|--------------------------|-----------------------|----------------|----|
| WINNERS | 1 | 414 | 1.7% | 38% | 8,950 | 7,280 | -1,671 | Mixed | 3.4 | 0.6 | Urban | terrace/flat | Rented | 5 |
| | 3 | 229 | 0.9% | 33% | 6,554 | 5,043 | -1,511 | Mixed | 3.4 | 0.7 | Urban | semi | LA Rented | 6 |
| | 2 | 405 | 1.6% | 12% | 6,813 | 4,681 | -2,132 | High-Med | 4.2 | 0.3 | Urban | semi/terrace | Mortgage/OO | 6 |
| | 4 | 493 | 2.0% | 22% | 4,740 | 3,498 | -1,242 | Med-Low | 3 | 0.5 | Urban | semi/terrace | Mortgage/OO | 6 |
| | 5 | 1274 | 5.2% | 76% | 3,982 | 3,419 | -563 | Low | 2 | 0.8 | Urban | terrace/flat/semi | LA Rented | 4 |
| | 11 | 361 | 1.5% | 60% | 564 | 1,897 | 1,333 | Low-Med | 1.6 | 0.5 | Village/Rural | semi/terrace | All LA Rented | 4 |
| | 13 | 366 | 1.5% | 43% | 120 | 1,759 | 1,639 | Med-Low | 2.1 | 0.5 | Village/Rural | detached/semi | OO/Mortgage | 5 |
| | 7 | 1098 | 4.5% | 0% | 2,447 | 1,658 | -789 | Med-High | 2 | 0.5 | Urban | flat/terrace/semi | Rented | 4 |
| | 9 | 1279 | 5.2% | 67% | 1,687 | 1,386 | -301 | Low-Med | 1 | 0 | Urban | flat | LA Rented | 3 |
| | 8 | 2254 | 9.2% | 44% | 1,797 | 1,297 | -500 | Med-Low | 2 | 0.6 | Urban | semi/terrace | OO/Mortgage | 5 |
| | 6 | 739 | 3.0% | 0% | 2,472 | 1,091 | -1,380 | High | 3 | 0.3 | Urban | semi/terrace/detached | Mortgage | 6 |
| | 12 | 2100 | 8.5% | 68% | 256 | 228 | -28 | Low-Med | 1 | 0.7 | Urban | terrace/flat | LA Rented | 5 |
| | 28 | 304 | 1.2% | 34% | -5,350 | 196 | 5,546 | Mixed | 1.8 | 0.6 | NI | terrace/semi | Mortgage/OO | 5 |
| | 20 | 289 | 1.2% | 64% | -2,238 | 179 | 2,417 | Low-Med | 1 | 0.2 | Village/Rural | detached/semi | Owned | 5 |
| 14 | 1122 | 4.6% | 100% | 57 | 36 | -21 | Low | 1 | 0.1 | Urban | terrace/semi | Owned | 5 | |
| LOSERS | 16 | 1149 | 4.7% | 22% | -210 | -424 | -213 | Med-Low | 2 | 1 | Urban | semi/detached | Mortgage/OO | 7 |
| | 25 | 350 | 1.4% | 19% | -3,729 | -542 | 3,187 | Mixed | 2 | 0.5 | Village/Rural | detached | OO/Mortgage | 7 |
| | 10 | 254 | 1.0% | 8% | 637 | -544 | -1,181 | Mixed | 3.4 | 0.7 | Urban | detached | Mortgage | 10 |
| | 15 | 3413 | 13.9% | 0% | 54 | -622 | -676 | High-Med | 2 | 0.5 | Urban | semi/terrace | Mortgage | 5 |
| | 22 | 437 | 1.8% | 0% | -2,603 | -1,194 | 1,410 | High-Med | 1.8 | 0.4 | Village/Rural | semi/terrace | Mortgage | 5 |
| | 17 | 242 | 1.0% | 6% | -282 | -1,262 | -980 | Mixed | 3.3 | 0.6 | Urban | detached | Mortgage/OO | 8 |
| | 27 | 225 | 0.9% | 0% | -4,687 | -1,645 | 3,042 | High-Med | 2 | 0.2 | Village/Rural | detached | Mortgage/OO | 5 |
| | 18 | 2256 | 9.2% | 0% | -1,472 | -1,709 | -237 | Med-High | 1 | 0.1 | Urban | terrace/semi/terrace | Mortgage/OO | 5 |
| | 21 | 407 | 1.7% | 49% | -2,320 | -2,081 | 239 | Med-Low | 1 | 0.4 | Urban | semi/detached/terrace | Owned | 7 |
| | 19 | 841 | 3.4% | 0% | -1,798 | -2,397 | -598 | High | 1.8 | 0 | Urban | detached/semi | Mortgage/OO | 7 |
| | 30 | 364 | 1.5% | 13% | -6,783 | -2,650 | 4,133 | Mixed | 2 | 0.7 | Village/Rural | detached | OO/Mortgage | 8 |
| | 24 | 257 | 1.0% | 21% | -2,987 | -2,768 | 218 | Med-Low | 1.8 | 1 | Urban | detached/semi | OO/Mortgage | 10 |
| | 23 | 501 | 2.0% | 0% | -2,921 | -2,843 | 79 | High | 2 | 1.7 | Urban | detached/semi | Mortgage | 7 |
| | 32 | 202 | 0.8% | 26% | -10,798 | -4,248 | 6,550 | Mixed | 2.2 | 1 | NI | detached | Mortgage/OO | 8 |
| | 26 | 239 | 1.0% | 0% | -4,405 | -4,270 | 135 | High | 1.9 | 1.3 | Urban | detached | Mortgage/OO | 10 |
| | 29 | 306 | 1.20% | 0% | -5,863 | -5,962 | -99 | High | 1.9 | 0.8 | Urban | detached | Mortgage | 10 |
| | 31 | 215 | 0.9% | 0% | -10,045 | -6,322 | 3,723 | High | 2.1 | 0.5 | Village/Rural | detached | Mortgage/OO | 8 |
| | 33 | 248 | 1.0% | 7% | -14,299 | -9,745 | 4,554 | Mixed | 2.3 | 0.9 | Village/Rural | detached | Mortgage/OO | 11 |

Low income clusters made better off under the modified allowance allocation rules

By definition, households in each of the clusters created through the CHAID analysis and shown in Table 9 have similar defining characteristics. The specific characteristics of these groups can therefore be described to provide some colour – a ‘real world’ feel – of the types of household in question. This characterisation makes it possible to focus on particular groups of concern – namely low income losing clusters.

As Table 9 shows, two previously losing low income groups (group 28 and 20 in the table) are now experiencing a mean surplus of allowances. Group 28 is a cluster of low income households in Northern Ireland with oil central heating; group 20 is a cluster of single pensioners in detached houses in rural areas. Both these household clusters suffered a mean allowance deficit under the equal per adult allocation, and this could largely be explained by ‘structural’ factors – i.e. oil central heating for the former; and type and location of the house for the latter. By targeting these factors with allowances in the modified allocation rules, the negative effect of these structural factors has been reduced.

| | |
|----------------------------------------------------------------------------------------|----------------------------------------------------------------|
| Key success stories of the modified allocation rules applied to all households: | |
| Node 28 | Low income households (all NI) with oil central heating |
| Node 20 | Low income single pensioners in detached houses in rural areas |

| | |
|---------|----------------------------------------------------------------|
| Node 28 | Low income households (all NI) with oil central heating |
| Node 20 | Low income single pensioners in detached houses in rural areas |

Groups 11 and 13 in Table 9 did experience a surplus of allowances under the equal per adult allocation, although this surplus was relatively small (564 and 120g CO₂ respectively). Under the modified allowance allocation rules, the mean surplus increases to nearer 2 tCO₂. Both these clusters represent potentially vulnerable households, consisting of mainly low income pensioners in rural areas. It is therefore encouraging that they experience a more clear-cut allowance surplus under the modified allowance allocation, suggesting they may stand to gain from such a PCT system.

Low income clusters losing under the modified allowance allocation rules

Group 14, on the other hand, also represents a very low income, potentially vulnerable cluster of single pensioners: whilst this group does experience a surplus, this has been reduced slightly under the new allocation rules and is only just above zero. This may be a cause for concern, as any increase in fuel consumption (for example, as a result of a very cold winter) could see these households experience a deficit in allowances. The characteristics of these households are such that they do not benefit substantially from the modified allocation rules, and receive limited allowances due to only one adult occupant.

Clusters that contain some (more than 50,000) households in income decile 1 to 3 and are (still) losing under the modified allocation rules (applied to all households) are shown in the table below, with a brief description of the characteristics of the cluster and possible explanations as to why they are experiencing a deficit, despite the modifications to the allocation rules.

Table 10: Losing clusters that contain more than 50,000 households in income deciles 1 to 3

| Node* | Description | Possible reason for deficit |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 16 | More of a middle-income node: 2-adult households, in urban and fringe areas with 7-8 rooms, vehicles and children. | High vehicle ownership and fairly large houses. |
| 25 | Low income households in this node are likely to be pensioners, living in rural, detached houses, with vehicles, and some oil central heating. | This node is losing significantly less than previously, which shows the effect of compensating households for the oil central heating, detached and rural aspect. High vehicle ownership could be the reason for the continued deficit. |
| 30 | 'Empty nesters' in rural areas - 2 adults, 2 cars, large detached houses, some with oil. | This node is losing by significantly less, which is likely due to the compensation on oil, rurality and built form. The low income households in this cluster are likely to be pensioners and the deficit a result of under-occupation. |
| 24 | More of a middle income node- similar to node 30- 2 adults, with vehicles, detached houses, but with more rooms and in urban areas. | Under-occupancy – all households have 9 or more rooms, but predominantly no children. Vehicle ownership is also likely to contribute to the deficit experienced. |
| 32 | Mixed income node all in Northern Ireland: large houses, oil, children and cars. | Very like node 28 (which is now winning – see above) except larger houses (lack of rurality data on NI in the EFS is likely to acerbate the lack of additional allowances received by these households). |

* Node number refers to the 'cluster' number as shown in Table 9.

4 IMPACT MITIGATION THROUGH FINANCIAL COMPENSATION

This section explores the potential for financial compensation as a means of mitigating the negative impacts of personal carbon trading on low income households. The aim of this approach is to provide a monetary sum to ‘low income’ households to reflect the cost of any carbon allowance deficit that is or may be experienced, thereby providing financial means to cope with that deficit (for example, either through purchasing additional allowances or investing in carbon reduction measures).

Again, household benefits status in the EFS is used as a mechanism for identifying ‘low income’ households in the dataset. The suitability of this identification approach, as touched upon in section 3.3.1, is explored in more detail here, by comparing benefits information with household income data (both contained within the EFS). The cost of financially compensating these households identified as ‘low income’ is then explored under a range of compensation scenarios and carbon prices.

4.1 TARGETING LOW INCOME HOUSEHOLDS THROUGH THE BENEFITS SYSTEM

Analysis of EFS household benefits information and household income shows that over half of households (56%) in the lowest three income deciles are in receipt of one or more of the following: council tax benefit (CT), income support (IS), housing benefit (HB), job-seekers allowance (JSA) or pension credit (PC). By using benefits information in the EFS to identify ‘low income’ income households for financial compensation, therefore, sees nearly half of the lowest three income deciles excluded. If the state pension is also included, this figure falls to 20%, but sees 39% and 16% of the middle and upper income decile groups respectively identified for financial compensation, as shown in Table 11.

Table 11: Proportion of income decile group in receipt of specified benefits

| Benefits status | Income decile group | | |
|------------------------------------|---------------------|--------|---------|
| | 1 to 3 | 4 to 7 | 8 to 10 |
| CT/ IS/ HB/ JSA/ PC | 56% | 12% | 4% |
| CT/ IS/ HB/ JSA/ PC/ State pension | 80% | 39% | 16% |

Figure 8: Proportion of households on benefits by income decile group

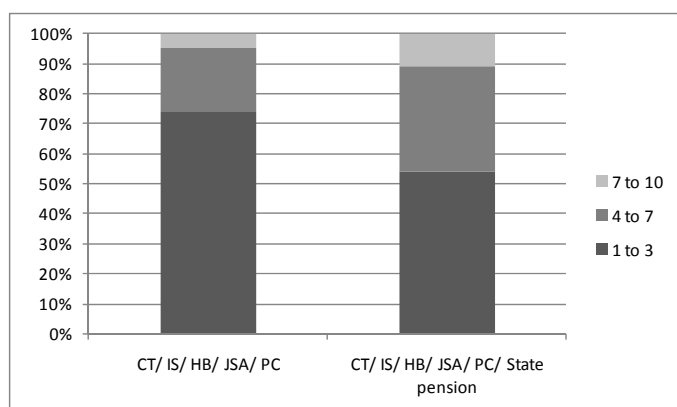
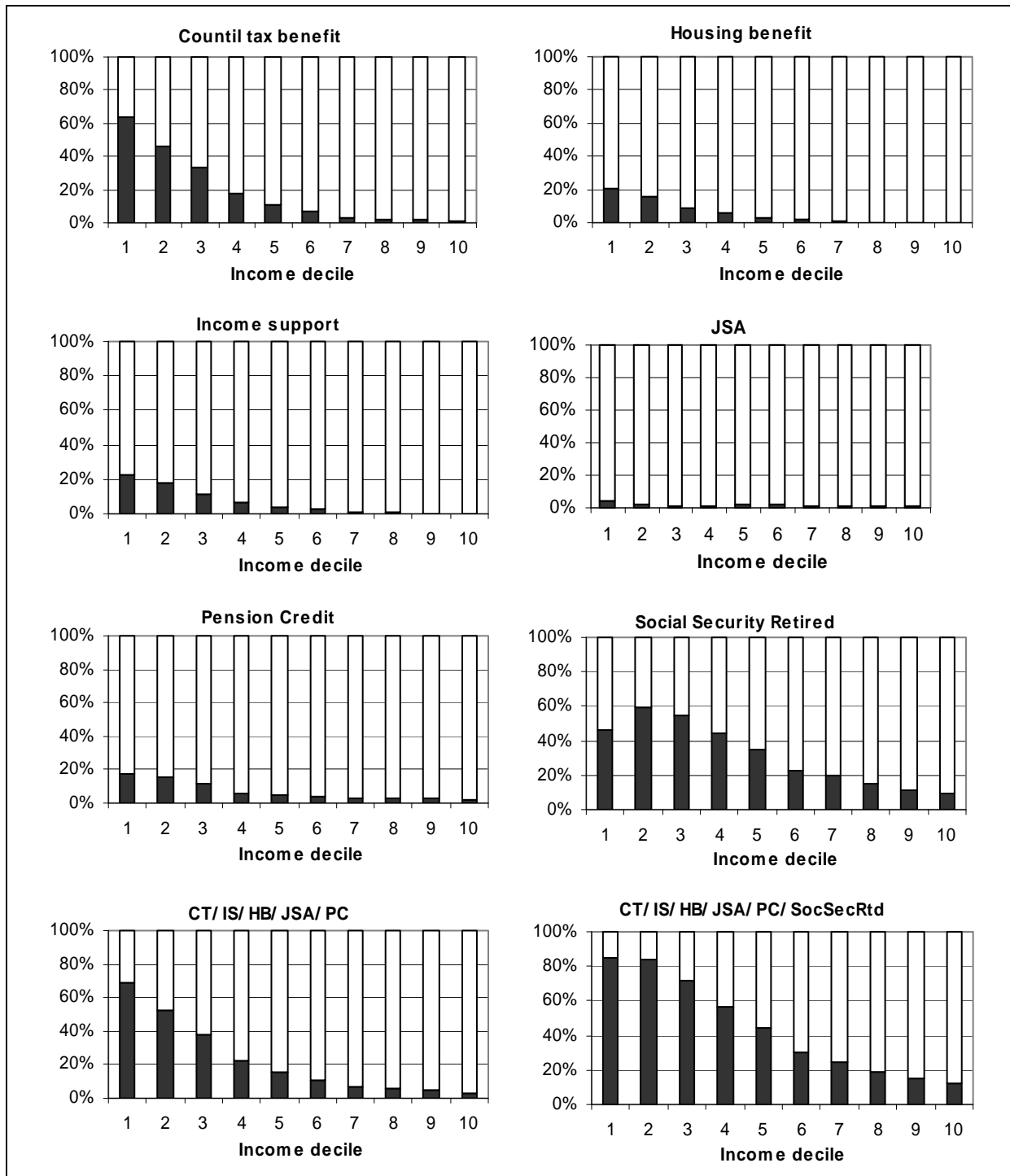


Figure 8 shows the proportion of all households in receipt of the specified benefits by income decile group. This shows that over 70% of all households claiming these benefits are in the lowest three income deciles. When the state pension is included, this falls to just over 50% (i.e. a higher proportion of higher income households are in receipt of the state pension).

A detailed breakdown of the proportion of households in each income decile in receipt of each of these benefits is shown in Figure 9.

Figure 9: (Equivalentised) income deciles and benefit recipients



Section 3.3.1 showed that even when the modified allowance rules are applied to households in receipt of benefits only (in an attempt to target low income households), around 27% of the lowest three income deciles still experience a deficit in allowances (only 3% less than under an equal per adult allowance allocation) and 24% of all households on benefits experience a deficit.

Under all three carbon allowance allocation systems modelled there are around 1.1m households that are in allowance deficit, are in the lowest three income deciles (although half of these are in decile 3), but are not in receipt of benefits included in the EFS dataset. This suggests there are a significant number of households that may be disadvantaged under a PCT system but may be difficult to target through reliance on benefits status.

Including all households in receipt of the State pension, however, sees only 7% of income deciles 1 to 3 classed as being in allowance deficit and not in receipt of any of the specified benefits and/or State pension (see Table 12 below, taken from Table 7) – i.e. if all pensioners and households on in receipt of certain income-related benefits are targeted for compensation, only 7% of ‘losers’ in the lowest three income deciles will not be reached.

Table 12: Proportion of households in deficit by income decile group and benefits/pension status

| Income decile group & benefits status | | Scenario 1 - Equal per adult allocation | Scenario 2 –Allocation rules low income HHs | Scenario 3 – Allocation rules all HHs |
|---------------------------------------|----------------|-----------------------------------------|---------------------------------------------|---------------------------------------|
| CT/ IS/ HB/ JSA/ PC/ State Pension | Deciles 1 - 3 | No | 7% | 7% |
| | | Yes | 22% | 20% |
| | Deciles 4 - 7 | No | 26% | 28% |
| | | Yes | 14% | 14% |
| | Deciles 8 - 10 | No | 46% | 47% |
| | | Yes | 9% | 9% |

Research by the Department of Work and Pensions (DWP) suggests that take-up of benefits by over-60’s is likely to be lower than for the rest of the population. For example, DWP reports that for 2004/05, take-up of pension credit was only 61-69%, compared to 80-90% for other benefits² - i.e. some 30-40% of all pensioners entitled to Pension Credit are not claiming the benefit. Furthermore, pensioners are recognised as a key ‘at risk’ group in relation to fuel poverty and the associated health impacts of living in cold, damp homes³. Therefore relying on benefits data as a proxy measure for low income, but not including the State pension in this measure, risks overlooking a potentially vulnerable household group. On the other hand, including the State pension in the proxy measure of low income then sees a large proportion of higher income households being classed as “low income” – 49% of all households in receipt of the State pension are in income deciles 4 and above (Figure 8).

This section of the report explores the potential for compensating ‘low income’ households financially, for any deficit they may or may not experience under a PCT system. Low income households will again be identified as those in receipt of council tax benefit, income support, housing benefit, jobs seekers allowance, or pension credit. For comparison, and based on the discussion above and results presented in section 3.3.1, the results of compensating all households in receipt of one or more of these benefits and/or the State pension are also presented.

4.2 COMPENSATING LOW INCOME HOUSEHOLDS FINANCIALLY

The cost of financially compensating households identified as ‘low income’ is explored under four scenarios and a range of different carbon prices. The four scenarios relate to whether only ‘low income’ losing households are awarded financial compensation for the exact value of their allowance deficit, under each of the allowance allocation scenarios modelled, versus whether all ‘low income’ households are awarded financial compensation regardless of whether they experience a deficit in allowances. In the latter case, the cost of allocating compensation at the mean and median level of deficit for all ‘low income’ losing households is explored. These scenarios are summarised below. Table 14 and Table 15 show the mean and median level of deficit of ‘low income’ households, using the two different proxy measures described above, by allowance allocation scenario.

Table 13: Financial compensation scenarios

| Compensation scenario | Household in allowance deficit? | Proxy measure of low income status | Level of financial compensation |
|--------------------------|---------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Compensation scenario 1: | Yes | In receipt of housing benefit, council tax benefit, income support, job-seekers allowance (income-based) or pension credit. | Equal to exact household allowance deficit under each of the three allocation scenarios |
| Compensation scenario 2: | Yes | In receipt of housing benefit, council tax benefit, income support, job-seekers allowance (income-based), pension credit or the State pension | Equal to exact household allowance deficit under each of the three allocation scenarios |
| Compensation scenario 3: | No | Households in receipt of housing benefit, council tax benefit, income support, job-seekers allowance (income-based) or pension credit. | Equal to mean (<i>or median</i>) allowance deficit for ‘low income’ group under each of the three allocation scenarios |
| Compensation scenario 4: | No | In receipt of housing benefit, council tax benefit, income support, job-seekers allowance (income-based), pension credit or the State pension. | Equal to mean (<i>or median</i>) allowance deficit for ‘low income’ group under each of the three allocation scenarios |

Table 14: Descriptive statistics: ‘low income’ and in allowance deficit

| Allowance allocation scenario | Count (1,000’s) | Mean deficit (kg CO ₂) | Median deficit (kg CO ₂) |
|---------------------------------------------|-----------------|------------------------------------|--------------------------------------|
| Equal per adult allocation | 1,615 | -3,896 | -2,241 |
| Modified allocation rules: ‘Low income’ HHS | 1,364 | -3,530 | -2,089 |
| Modified allocation rules: All HHS | 1,751 | -3,386 | -2,020 |

Table 15: Descriptive statistics: ‘low income’ and/or State pensioner and in allowance deficit

| Allowance allocation scenario | Count (1,000’s) | Mean deficit (kg CO ₂) | Median deficit (kg CO ₂) |
|----------------------------------------------|-----------------|------------------------------------|--------------------------------------|
| Scenario 1 - Equal per adult allocation | 3,646 | -4,441 | -2,234 |
| Scenario 2 – Allocation rules low income HHS | 3,501 | -4,298 | -2,159 |
| Scenario 3 – Allocation rules all HHS | 3,864 | -3,709 | -2,056 |

In addition to the four compensation scenarios described above, five carbon price scenarios are applied, where the cost per tonne of CO₂ varies as follows:

- a. £15 / tonne
- b. £25 / tonne
- c. £35 / tonne
- d. £40 / tonne
- e. £50 / tonne

These compensation and carbon price scenarios are combined and applied under each of the three carbon allowance allocation scenarios (equal per adult allocation; modified allocation rules applied to 'low income households'; and modified allocation rules applied to all households).

4.3 IMPACT OF FINANCIALLY COMPENSATING LOW INCOME HOUSEHOLDS

Table 16 shows the number of households receiving financial compensation under all the compensation scenarios. For compensation scenarios 1 and 2, the number of households receiving compensation is based on the number of 'low income' households (as defined by the two proxy measures) losing under each of the allowance allocation scenarios. This sees 1.4 to 1.8 million (depending on the allowance allocation scenario) households compensated, rising to 3.5 to 3.9 million when all state pensioner households are included.

For compensation scenarios 3 and 4, all 'low income' households (according to the two proxy measures) are compensated regardless of whether they experience a deficit in allowances, hence the allowance allocation scenario is not relevant here. This sees 5.6 million households compensated, rising to 10.9 million when all state pensioner households are included.

Table 16: Proportion of households receiving financial compensation under the different compensation and allowance allocation scenarios

| Compensation scenario | Allowance allocation scenario | Total | |
|-----------------------|--------------------------------------|----------------|-----|
| | | Count (1,000s) | % |
| 1 | Equal per adult | 1,614 | 7% |
| | Rules applied to low income HHs only | 1,364 | 6% |
| | Rules applied to all HHs | 1,752 | 7% |
| 2 | Equal per adult | 3,646 | 15% |
| | Rules applied to low income HHs only | 3,501 | 14% |
| | Rules applied to all HHs | 3,864 | 16% |
| 3 | n/a | 5,630 | 23% |
| 4 | n/a | 10,919 | 44% |

Table 17 shows the average value of financial compensation to households under the various compensation scenarios. As compensations scenarios 3 and 4 universally allocate the mean allowance deficit of the 'low income' population identified (i.e. rather than compensating for the exact value of deficit on an individual household level as with scenarios 1 and 2), the mean compensation values shown are the same for scenarios 1 and 3, and scenarios 2 and 4 respectively.

The mean value of financial compensation to a single household varies substantially between £51 and £222, depending on the allowance allocation system and carbon price applied. Applying the carbon prices to median value of deficit, rather than the mean, under compensation scenarios 3 and 4 reduces the rate of compensation to households by almost half.

Table 17: Mean compensation value per household

| Compensation scenario | Allowance allocation scenario | Carbon price scenario: | | | | |
|-----------------------|---------------------------------------------|------------------------|------------|------------|------------|-------------|
| | | A - £15/t | B - £25/t | C - £35/t | D - £40/t | E - £50/t |
| 1 (& 3) | Equal per adult | £58 | £97 | £136 | £156 | £195 |
| | Rules applied to low income HHs only | £53 | £88 | £124 | £141 | £177 |
| | Rules applied to all HHs | £51 | £85 | £119 | £135 | £169 |
| 2 (& 4) | Equal per adult | £67 | £111 | £155 | £178 | £222 |
| | Rules applied to low income HHs only | £64 | £107 | £150 | £172 | £215 |
| | Rules applied to all HHs | £56 | £93 | £130 | £148 | £185 |
| 3 median | <i>Equal per adult</i> | <i>£34</i> | <i>£56</i> | <i>£78</i> | <i>£90</i> | <i>£112</i> |
| | <i>Rules applied to low income HHs only</i> | <i>£31</i> | <i>£52</i> | <i>£73</i> | <i>£84</i> | <i>£104</i> |
| | <i>Rules applied to all HHs</i> | <i>£30</i> | <i>£50</i> | <i>£71</i> | <i>£81</i> | <i>£101</i> |
| 4 median | <i>Equal per adult</i> | <i>£34</i> | <i>£56</i> | <i>£78</i> | <i>£89</i> | <i>£112</i> |
| | <i>Rules applied to low income HHs only</i> | <i>£32</i> | <i>£54</i> | <i>£76</i> | <i>£86</i> | <i>£108</i> |
| | <i>Rules applied to all HHs</i> | <i>£31</i> | <i>£51</i> | <i>£72</i> | <i>£82</i> | <i>£103</i> |

The total cost of financially compensating 'low income' households under the different compensation scenarios is shown in Table 18. When all households suffering a deficit in allowances and in receipt of housing benefit, council tax benefit, income support, job-seekers allowance (income-based) or pension credit are financially compensated for the exact value of that deficit, the total cost is between £72 and £315 million, depending on the initial carbon allowance allocation system (which determines the extent of allowance deficit) and the price per tonne of carbon (compensation scenario 1, Table 18). These households receive an average of £51 to £195 in compensation as shown in Table 17 (but there will be significant variation in the value received).

If all 'losing' pensioner households are also financially compensated, in addition to losing households on the specified income-related benefits, (compensation scenario 2), the total cost rises to between £215 and £810 million, again depending on the initial carbon allowance allocation system and the price per tonne of carbon applied (compensation scenario 2, Table 18).

The total cost of compensating all households in receipt of the specified benefits, regardless of whether they experience an allowance deficit or not, ranges from £286m to £1.1bn (depending on the carbon price and the allowance allocation scenario which determines the mean value allocated – see Table 14). When households in receipt of benefits and/or a State pension are compensated (compensation scenarios 3 and 4 in Table 18) with the mean value of deficit (see Table 15) the total cost rises to £607m to £2.4bn.

Applying the carbon prices to the median value of allowance deficit (as shown Table 14 and Table 15) reduces the total cost of compensation scenarios 3 & 4 by around a half.

Table 18: Total cost of compensation scenarios (millions)

| Compensation scenario | Allowance allocation scenario | Carbon price scenario: | | | | |
|-----------------------|---------------------------------------------|------------------------|-------------|-------------|-------------|---------------|
| | | A - £15/t | B - £25/t | C - £35/t | D - £40/t | E - £50/t |
| 1 | Equal per adult | £94 | £157 | £220 | £237 | £315 |
| | Rules applied to low income HHs only | £72 | £120 | £169 | £193 | £241 |
| | Rules applied to all HHs | £89 | £148 | £208 | £252 | £296 |
| 2 | Equal per adult | £243 | £405 | £567 | £648 | £810 |
| | Rules applied to low income HHs only | £226 | £376 | £527 | £602 | £752 |
| | Rules applied to all HHs | £215 | £358 | £502 | £573 | £717 |
| 3 | Equal per adult | £329 | £548 | £768 | £877 | £1,097 |
| | Rules applied to low income HHs only | £298 | £497 | £696 | £795 | £994 |
| | Rules applied to all HHs | £286 | £477 | £667 | £763 | £953 |
| 4 | Equal per adult | £727 | £1,212 | £1,697 | £1,940 | £2,425 |
| | Rules applied to low income HHs only | £704 | £1,173 | £1,643 | £1,877 | £2,347 |
| | Rules applied to all HHs | £607 | £1,012 | £1,417 | £1,620 | £2,025 |
| 3 median | <i>Equal per adult</i> | <i>£189</i> | <i>£315</i> | <i>£442</i> | <i>£505</i> | <i>£631</i> |
| | <i>Rules applied to low income HHs only</i> | <i>£176</i> | <i>£294</i> | <i>£412</i> | <i>£470</i> | <i>£588</i> |
| | <i>Rules applied to all HHs</i> | <i>£171</i> | <i>£284</i> | <i>£398</i> | <i>£455</i> | <i>£569</i> |
| 4 median | <i>Equal per adult</i> | <i>£366</i> | <i>£610</i> | <i>£854</i> | <i>£976</i> | <i>£1,220</i> |
| | <i>Rules applied to low income HHs only</i> | <i>£354</i> | <i>£589</i> | <i>£825</i> | <i>£943</i> | <i>£1,178</i> |
| | <i>Rules applied to all HHs</i> | <i>£337</i> | <i>£561</i> | <i>£786</i> | <i>£898</i> | <i>£1,122</i> |

5 CONCLUSION

Building on previous research, this report has explored the potential to mitigate the negative impacts of personal carbon trading on low income households, through two distinct approaches.

The first approach applied a set of modified carbon allowance allocation rules, the aim being to provide allowances for household characteristics that have been shown to increase the likelihood that a household will suffer a deficit in allowances. This approach appeared, on the whole, successful. Whilst the overall proportion of 'losing' households in the EFS dataset increased slightly, the impact of 'structural' factors on household allowance balance was reduced, reducing the spread of surplus/deficit, without impacting on any particular income group or 'lifestyle' factor. By reducing the extent of deficit suffered by 'losing' households, this effectively increases the likelihood that the household may be able to reduce its emissions to avoid deficit through behavioural change and no/low cost measures.

Analysis of the impact of the modified allowance allocation on the existing households clusters (created through CHAID analysis in CSE's previous work¹), highlight some notable success stories, where groups of low income households have been made better off as a result of the modified allocation. In particular, single pensioners in detached houses, in rural areas, and low income households with oil central heating appear better off as a result of the new allocation system. However, under-occupancy still seems to be a cause of deficit and is exacerbated for some households – if a household does not qualify for any (or very little) additional allowances under the modified rules they will be subject to an equal per adult allowance at a lower rate than without the modified rules. Whilst this may be a cause of concern where single, potentially vulnerable pensioners are living in large houses, this outcome does highlight the inefficiencies (in terms of household energy consumption) of under-occupation.

The second approach to impact mitigation modelled a system of financial compensation for 'low income' households. The results of the modelling showed that the costs of doing vary considerably depending on: how 'low income' households are defined and identified (i.e. whether all State pensioners are included); whether these households are compensated only if they are 'losing', for the exact value of their deficit, or if all identified 'low income' households are given financial compensation, regardless of household allowance balance; whether, in the case of the latter scenario, a mean or median value of deficit is applied to determine the level of compensation received; and finally the price per tonne of carbon applied. Providing financial compensation to 'low income' losing households for the exact value of their allowance deficit costs considerably less than providing compensation to all 'low income' households, regardless of household allowance balance. However, in practice the former is unlikely to be a feasible scenario.

On the whole, however, a personal carbon allowance allocation system is progressive, even without any financial compensation to 'low income' households. Modelling on the EFS dataset has shown that around 70% of income deciles 1, 2 and 3 experience a surplus of allowances under all allowance allocation scenarios modelled.

This research also provided opportunity to explore the potential for successfully identifying low income households through the benefits system, as the EFS dataset used for the modelling contains both actual household income and benefits status at a household level. This showed that 28% of the lowest income decile were not claiming any of the five key income-related benefits available in the EFS household dataset (council tax benefit, income support, housing benefits, job-seekers allowance and pension credit). This rises to 39% for income decile 2, and 64% for income decile 3. Including all households in receipt of the State Pension in the proxy measure reduces these figures to 18%, 14% and 28% respectively.

Combining the results of the carbon allowance allocation modelling and benefits/income analysis shows that 15% of the lowest three income deciles in the EFS dataset, and 10% of the lowest decile, experience a deficit in allowances under all allocation systems modelled and are not in receipt of benefits. This suggests around 250,000 of the poorest 10% of households (and 1 million of the poorest 30%) may be (1) at risk of suffering a deficit in carbon allowances under the PCT systems modelled here and (2) difficult to identify and target with compensatory measures.

6 ANNEX

Annex table 1: Proportion of households by income decile, benefit status and surplus/deficit

| Income decile | Benefit claimant | Scenario 1: Equal per adult allocation | | Scenario 2: Modified allocation rules, low income HHs | | Scenario 3: Modified allocation rules, all HHs | |
|---------------|------------------|----------------------------------------|---------|-------------------------------------------------------|---------|------------------------------------------------|---------|
| | | Deficit | Surplus | Deficit | Surplus | Deficit | Surplus |
| 1 | No | 10% | 19% | 10% | 18% | 11% | 18% |
| | Yes | 19% | 52% | 16% | 55% | 21% | 51% |
| 2 | No | 13% | 26% | 13% | 26% | 13% | 26% |
| | Yes | 15% | 46% | 12% | 49% | 16% | 46% |
| 3 | No | 21% | 43% | 22% | 42% | 21% | 43% |
| | Yes | 9% | 27% | 8% | 28% | 10% | 26% |
| 4 | No | 28% | 51% | 30% | 49% | 29% | 49% |
| | Yes | 6% | 15% | 5% | 17% | 6% | 15% |
| 5 | No | 33% | 55% | 34% | 54% | 35% | 53% |
| | Yes | 4% | 8% | 4% | 8% | 5% | 7% |
| 6 | No | 41% | 50% | 43% | 48% | 43% | 48% |
| | Yes | 3% | 6% | 2% | 6% | 3% | 5% |
| 7 | No | 44% | 51% | 46% | 49% | 48% | 47% |
| | Yes | 2% | 3% | 2% | 4% | 3% | 3% |
| 8 | No | 46% | 50% | 47% | 48% | 50% | 46% |
| | Yes | 2% | 2% | 2% | 2% | 3% | 2% |
| 9 | No | 51% | 44% | 53% | 43% | 56% | 40% |
| | Yes | 2% | 2% | 2% | 2% | 3% | 2% |
| 10 | No | 61% | 36% | 63% | 34% | 65% | 32% |
| | Yes | 3% | 1% | 3% | 1% | 3% | 0% |

Annex table 2: Proportion of households by income decile, benefit/State pension status and surplus/deficit

| Income decile | Benefit &/or State pension | Scenario 1: Equal per adult allocation | | Scenario 2: Modified allocation rules, low income HHs | | Scenario 3: Modified allocation rules, all HHs | |
|---------------|----------------------------|----------------------------------------|---------|-------------------------------------------------------|---------|------------------------------------------------|---------|
| | | Deficit | Surplus | Deficit | Surplus | Deficit | Surplus |
| 1 | No | 6% | 12% | 7% | 11% | 7% | 11% |
| | Yes | 23% | 59% | 20% | 62% | 24% | 58% |
| 2 | No | 5% | 8% | 5% | 8% | 5% | 8% |
| | Yes | 22% | 64% | 20% | 67% | 23% | 63% |
| 3 | No | 10% | 18% | 10% | 18% | 10% | 18% |
| | Yes | 20% | 51% | 20% | 52% | 21% | 50% |
| 4 | No | 17% | 27% | 18% | 26% | 18% | 26% |
| | Yes | 16% | 39% | 16% | 39% | 17% | 38% |
| 5 | No | 23% | 37% | 24% | 35% | 25% | 35% |
| | Yes | 14% | 27% | 14% | 27% | 15% | 26% |
| 6 | No | 31% | 38% | 32% | 36% | 33% | 36% |
| | Yes | 13% | 19% | 13% | 19% | 14% | 18% |
| 7 | No | 34% | 39% | 36% | 38% | 37% | 36% |
| | Yes | 12% | 15% | 12% | 15% | 13% | 14% |
| 8 | No | 38% | 42% | 40% | 41% | 42% | 39% |
| | Yes | 10% | 10% | 10% | 9% | 11% | 9% |
| 9 | No | 44% | 39% | 45% | 37% | 48% | 34% |
| | Yes | 9% | 8% | 10% | 8% | 10% | 7% |
| 10 | No | 55% | 33% | 57% | 31% | 59% | 29% |
| | Yes | 9% | 4% | 9% | 4% | 9% | 3% |

7 References

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