Article

Nowcasting household income in the UK: initial methodology

In order to properly understand changes in households' economic well-being, it is important to have measures which reflect the experience of the typical household and can also provide a description of the distribution. However, the complexities of producing such measures means they are typically only available with a significant time lag. This article therefore presents an initial methodlgy for producing early/provisional estimates of median equivalised disposable income and other measures. The accuracy of nowcast estimates based on this methodology are evaluated against data from ONS's publication the Effects of Taxes and Benefits on Household Income.

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Table of contents

1 . Background

In measuring how living standards have changed over time, median household disposable income is widely regarded as one of the most important indicators (see e.g. OECD, 2013, ONS, 2014, Stiglitz et al., 2009). Disposable income is the amount of money that households have available for spending and saving after accounting for direct taxes (such as income tax and council tax). It includes earnings from employment, private pensions and investments as well as cash benefits provided by the state. The median household income is the income of what would be the middle household, if all households in the UK were sorted in a list from poorest to richest. As it represents the middle of the income distribution, the median household income provides a good indication of the standard of living of the "typical" household in terms of income.

OECD (2013), Stiglitz et al. (2009) and others also emphasise the need to look at the distribution of income in assessing economic well-being. Doing this allows us to analyse not only a typical household but also those towards the top and bottom of the income distribution. There is a variety of inequality measures which are regularly produced based on disposable income such as the Gini coefficient or the S80/S20 ratio. The Gini coefficient, which ranges between 0 and 100, is perhaps the most commonly used measure of inequality. The lower the value of the Gini, the more equally household income is distributed, with 0 representing perfect equality and 100 representing perfect inequality. The S80/S20 ratio is the ratio of the total income received by the 20% of households with the highest income to that received by the 20% of households with the lowest income. The higher the ratio is the greater the inequality. Together these measures provide further information on how incomes are shared across households and how this is changing over time.

One important limitation in using such measures as proxies for changes in material living standards is their lack of timeliness. Unlike macro-economic indicators such as GDP per head or Real Household Disposable Income (RHDI), which are typically available within a few months, statistics on the distribution of income in the UK and other countries are typically produced to a much longer timetable, reflecting to the complexity involved in collecting, processing and analysing household financial survey data. For example, ONS's Effects of Taxes and Benefits on Household Income publication has historically been released in June, approximately 15 months after the end of the income reference period.

Up-to-date measures of household incomes provide a valuable tool for evaluating the impact of tax and benefit policies and for informing wider public debate on living standards. In order to address the considerable demand for more timely data it is necessary to consider the use of alternative methods for arriving at early distributional estimates, such as nowcasting. Nowcasting is an increasingly popular approach for providing initial estimates of such indicators. Unlike forecasting, which relies heavily on projections and assumptions about the future economic situation, nowcasting uses data on the income distribution for previous years, information on current tax and benefit policies, and key macro-economic variables to estimate current indicators. This paper presents an initial methodology for nowcasting some of the main indicators from ONS's Effects of Taxes and Benefits series in order to provide users with an early insight into the latest trends.

A number of organisations, including the Institute for Fiscal Studies (IFS), Resolution Foundation and New Policy Institute (NPI) have already carried out extensive work on nowcasting various income and poverty indicators for the UK. At an international level, Holly Sutherland and colleagues at the Institute of Social and Economic Research (ISER) have produced estimates of current income, risk-of-poverty and inequality for a number of other EU countries. ONS have aimed to learn from this existing research in developing this initial nowcasting methodology.

In order to estimate current median income and other distributional measures, it is important to capture how changes in macro-economic conditions affect households at different points of the income distribution. Microsimulation models are appropriate tools for taking into account the complex interactions between policy and changing household circumstances (Immervoll et al., 2006). In the context of nowcasting, these models can simulate how changes to the structure of the tax and benefit system impact the distribution of disposable income.

Beyond reflecting changes in policies and the levels of income from sources such as earnings, the main challenge in nowcasting is to adequately incorporate labour market and demographic changes into the microsimulation analysis. There are two basic methods used in the nowcasting literature for taking account of labour market changes. The first, which is the method presented in this paper, is re-weighting, which involves re-calculation of weights to reflect the change in the number of people with a different socio-economic status. This method is sometimes referred to as 'static aging' (Immervoll et al. 2005). Under this approach, in order to account for socio-demographic changes, the weights of the data are re-calculated so that in the newly weighted dataset, the number of households with certain characteristics matches a set of control totals for the current population. Some of the dimensions that might be controlled for include household size, age, gender, region and employment. In combination with the uprating of financial variables, this allows for a 'synthetic' population for later years to be produced.

The second method introduces a dynamic element into the static microsimulation approach, by explicitly simulating the transitions between labour market states. This approach was used by Navicke et al. (2013) who employed EUROMOD (the tax-benefit microsimulation model for the European Union) to estimate the distribution of income in 13 Member States. Labour-market changes were accounted for by explicitly simulating the transition between labour market states. The weighted total number of individuals who were selected to go through transitions corresponded to the relative net change in employment rates by age group, gender and education. For those individuals moving out of employment, employment income was set to zero and for those moving into employment, earnings were set equal to the average among individuals employed within the same stratum.

2 . Methodology

In the work reported in this paper, historical income data were used to nowcast the 2013/14 distribution of disposable income. These nowcast data were then compared to published estimates from the latest Effects of Taxes & Benefits on Household Income release, published 29 June 2015.

In order to capture how changes in macro-economic conditions affect households at different points of the income distribution, existing microsimulation tools used by the UK Government were combined with additional adjustments needed to reflect changes in labour market and other population characteristics over time. The proposed nowcasting methodology can be summarised in the following steps:

- uprating income microdata to account for changes in financial variables such as growth in average wages

- implementing changes to cash benefits and direct taxes resulting from changes to rates, thresholds, etc

- implementing changes to cash benefits and direct taxes resulting from more structural policy reforms

- adjusting for changes to labour market participation and the demographic structure of the population through calibration weighting

Data sources

The nowcast data is built upon the Intra-Governmental Tax and Benefit Model (IGOTM). This is a microsimulation model of the UK tax and benefit system which allows for explicitly simulating the entire income distribution and for estimating the impact of tax and benefit changes that directly affect household incomes. IGOTM is maintained by HM Treasury, using data provided by ONS. It applies the rules of the current system to a large sample of household data to calculate net incomes after taxes and benefits.

The input data for IGOTM comes from the Living Costs and Food Survey (LCF) and The Effects of Taxes & Benefits on Household Income (ETB), which provide information on income, expenditure and important family characteristics. In order to improve precision of the estimates, the input dataset for IGOTM combines three years worth of data (2008/09, 2009/10 and 2010/11 for the current exercise).

Detailed methodology

Uprating financial variables

The first step of the nowcasting process is to uprate the base dataset that feeds into IGOTM to values for the year for which nowcast estimates are being produced. Different income sources are uprated by different factors, using published series produced by ONS and others for periods where actual data is available. Office for Budget Responsibility (OBR) average earnings and inflation forecasts are used in IGOTM for later periods.

Earnings data are uprated forward to reflect the financial year being modelled, using historical Annual Survey of Hours and Earnings (ASHE) data on earnings growth at different points across the distribution as well as the latest average earnings estimates from National Accounts. Individual employees are assumed to be paid at least the National Minimum Wage (NMW), which is projected to the financial year being modelled in line with the OBR average earnings forecast.

Other financial variables are uprated in the following way[1]:

- income from self-employment, incomes from odd jobs and private sector rents are uprated in line with average earnings

- incomes from private pensions, annuities and other miscellaneous sources are uprated in line with the RPI

- incomes from the main government benefits are uprated in line with the CPI, or other values as appropriate
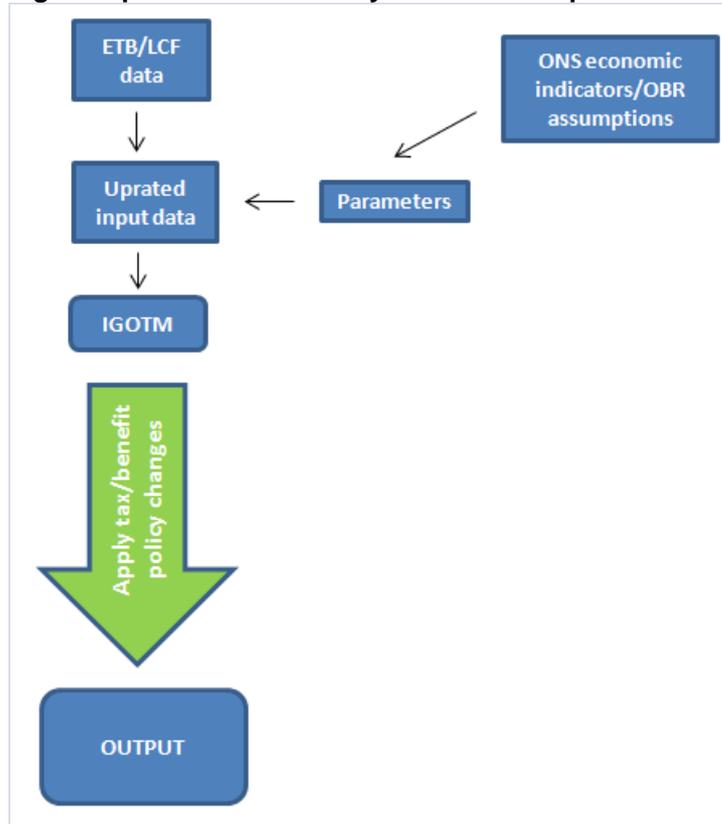
Implementing policy changes

Once the relevant parameters are uprated and the new input dataset is created, it is run through IGOTM where a new costing is produced. For each individual case the rules of the current tax and benefit system for the year being nowcast for are applied and the model calculates how much individual direct and indirect taxes are due and what level of benefits and tax credits would be received in that year. These rules are applied at either the individual, family (benefit unit) or household level as appropriate.

Some of the main tax and benefit changes occurring during 2013/14 included:

- **child and working tax credits:** The basic element of working tax credit frozen at £1,920 a year. The family element of child tax credit was also frozen at £545 a year, while the child element rose by £30 (around 1%) to £2,690. Disregard for in-year rises in income was reduced to £5,000 from £10,000

- **personal independence payment:** Disability Living Allowance replaced with a new benefit called Personal Independence Payment (PIP) for adults aged under 65 in England, Wales & Scotland. Eligibility for PIP is assessed using different criteria than for DLA. This assessment includes a review of an individual's ability to participate fully in society rather than the severity of impairment. PIP also involves continuing assessment of claimants' needs

- **housing benefit:** Households in England, Scotland and Wales deemed to be under-occupying socially rented accommodation had their Housing Benefit reduced

- **child benefit:** First full year of the High Income Child Benefit charge for households where at least one spouse or partner has income in excess of £50,000

- **benefit uprating:** Benefits for working age people, including Job Seekers Allowance, Income Support and Employment & Support Allowance were increased by 1% in April 2013, below the rate of inflation. Benefits received by disabled people and pensioners (including Disability Living Allowance, Attendance Allowance and Incapacity Benefit) were increased in line with CPI (2.2%). The State Pension increased by 2.5% due to the 'triple lock'

- **benefit cap:** A cap was introduced to the total amount of benefits people aged 16 to 64 can receive in England, Scotland and Wales

- **income tax:** The personal allowance for those under 65 at beginning of tax year increased from £8,105 to £9,440. By contrast, the personal allowances for those aged 65-74 and 75+at the start of 2013/14 remained at £10,500 and £10,660 respectively. In addition, there was a reduction in the starting level for the higher rate band, from £34,371 to £32,011

- **council tax:** In 2013/14, 61% of eligible local authorities in England made use of a Council Tax freeze grant. This meant that the average Council Tax bill for a band D dwelling increased by just 0.8% on 2012 /13. Council Tax levels were frozen in all local authorities in Scotland. However, in Wales, the average band D Council Tax increased by 3.2% compared with 2012/13

From 2014/15 the model assumes incomplete take-up of benefits and tax credits. However, this take-up modelling is not available for the period for which these nowcasts have been produced (2013/14), possibly leading to the overstatement of certain benefit receipts.

Figure 1 provides a summary of the IGOTM process:

Although very similar, the income measures produced through IGOTM are not identical to those used by ONS for its ETB publication. Wherever possible, further adjustments are made to align IGOTM income variables with those from ETB.

Accounting for labour market and demographic changes

As a static micro-simulation model, IGOTM does not take account of any possible behavioural responses to policy changes or make adjustments for demographic changes. It assumes, for example, that the supply of labour is unchanged in response to changes in benefit entitlement. We have chosen to re-calibrate the original ETB weights to account for shifts in labour market participation and demographic characteristics of the UK population between the period when the LCF data were collected and the period for which nowcasts are being produced.

For the main ETB dataset and publication, each household in the microdata is initially given a design weight to account for the probability of selection in the sample. These weights are then adjusted to reduce bias from non-response and the sample distribution is calibrated to match the population distribution in terms of region, age group and sex.

In order to ensure consistency between the nowcasts and the actual data, it is desirable for the non-response adjusted design weights to be calibrated using new population totals matching those used for the original weights. Hence, the re-calibrated weights are calculated using the same calibration variables as the original ETB weights, along with an additional calibration constraint - Economic Status. This allows the incorporation of labour market changes in the analysis. Under the version of the nowcasting methodology presented in this paper, individuals are grouped in five categories according to their economic status – self-employed, in employment, International Labour Organisation (ILO) unemployed, inactive and under 16.

Population totals for this additional calibration constraint are based on estimates coming directly from the Annual Population Survey, as opposed to the regional, age group and sex population controls, projections for which are taken from the most recent Census and updated annually by birth and death counts, as well as by immigration estimates coming from the International Passenger Survey (IPS). As the Economic Status estimates are drawn from a sample survey (albeit one with a very large sample) the level of precision will be lower. Nevertheless, including this additional calibration constraint is important as changes in levels and patterns of labour market participation are likely to be a key driver of changes to household incomes.

In order to avoid introducing too many constraints, full-time and part-time employment are not currently modelled separately, though this may be considered for future versions of the methodology.

The full list of population totals used for calibration are presented in the Technical Annex. In conjunction with the uprating and simulation of policy changes, this process enables us to create a 'synthetic' population for the relevant year.
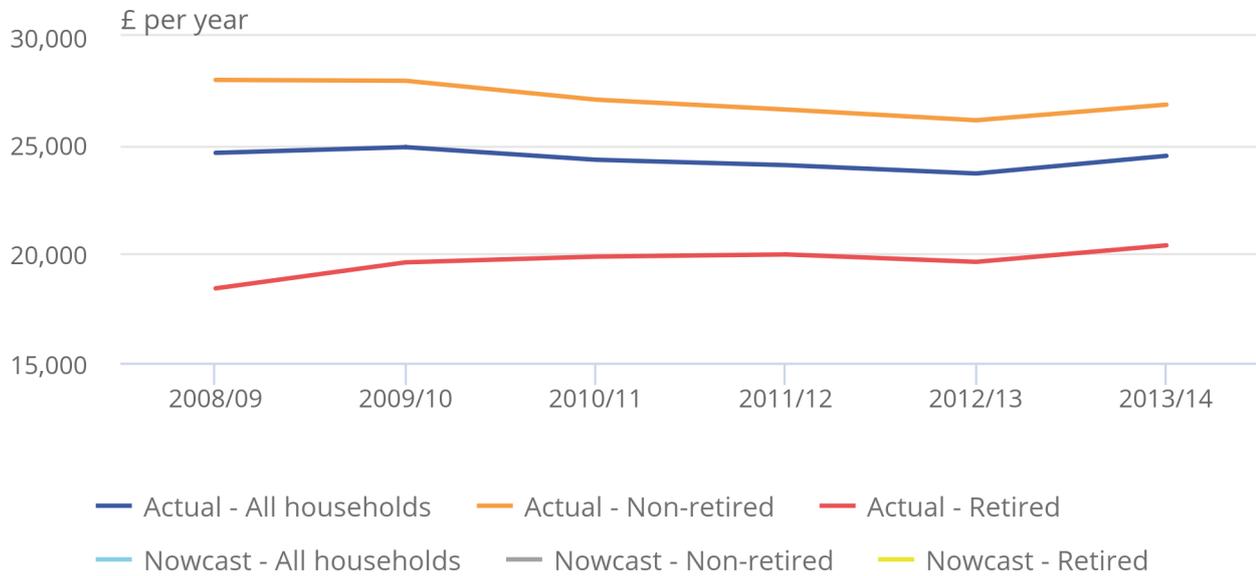
Notes for Methodology

1. For a full table with uprating factors see Technical Annex

3 . Nowcasting results for 2013/14

Figures 2 and 3 show the evolution of median and mean equivalised disposable income, respectively, using published ETB estimates. Also shown are nowcast estimates for 2013/14. The nowcast values for the mean and median disposable incomes for all households and non-retired households are very close to the published estimates for 2013/14, with the confidence intervals for the nowcast medians overlapping the published estimates. However, the nowcast estimates for retired households are are further apart from the published values, not fully reflecting the growth in average incomes for retired households which occurred over this period.

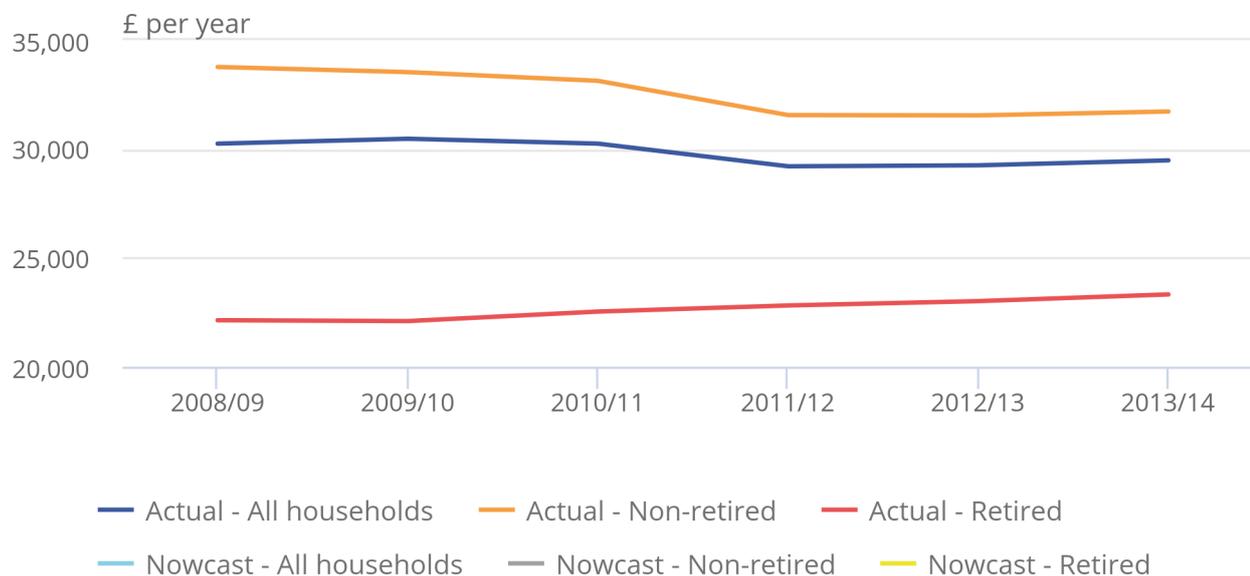## Figure 2: Median equivalised disposable income - actual and nowcast estimates (2013/14 prices)

Notes:

1. Using the modified-OECD scale

2. All income figures have been deflated to 2013/14 prices using an implied deflator for the household

3. 95% confidence intervals for nowcast estimates included (reflecting sampling variability)

Figure 3: Mean equivalised disposable income - actual and nowcast estimates (2013/14 prices)

Notes:

1. Using the modified-OECD scale

2. All income figures have been deflated to 2013/14 prices using an implied deflator for the household sector

3. 95% confidence intervals for nowcast estimates included (reflecting sampling variability)

Figure 4 presents nowcast and survey-based Gini coefficients for different household types. As with the income measures, the nowcast estimates very closely reflect the published Gini coefficients for both all households and non-retired households, but the slight increase in income inequality among retired households in recent years in the published estimates is not fully reflected in the nowcasts.
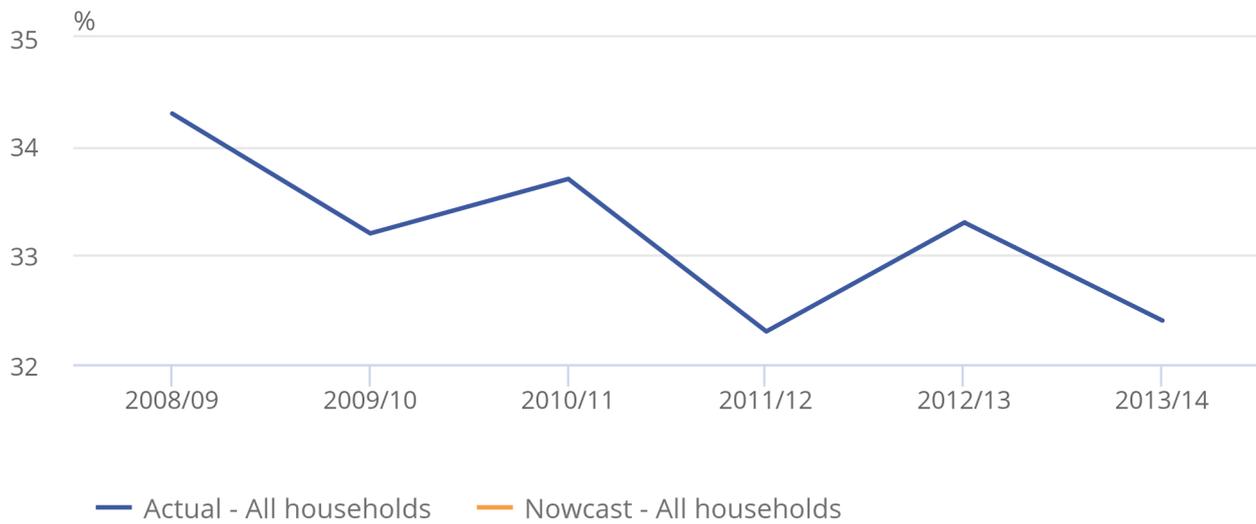
The differences between the nowcast and survey based estimates for retired households appear to be related to private pensions and annuities. Over recent years, the survey based estimates have shown substantial growth, both in the number of households receiving income from this source and the average value of those pensions. The current iteration of the nowcast methodology has not fully reflected this growth. In the nowcast data, 5.46 million retired households are identified as receiving income from occupational pensions, with an average pension income of £216 a week. By contrast, in the ETB survey based estimates, the equivalent figures are 5.56 million households and £235 a week. The next iteration of the nowcasting methodology will consider ways to ensure such changes are better reflected in the estimates.

Figure 4i: Gini coefficients 2008/09 to 2013/14

All households

Figure 4i: Gini coefficients 2008/09 to 2013/14

All households

%

35					
34					
33					
32					

2008/09 2009/10 2010/11 2011/12 2012/13 2013/14

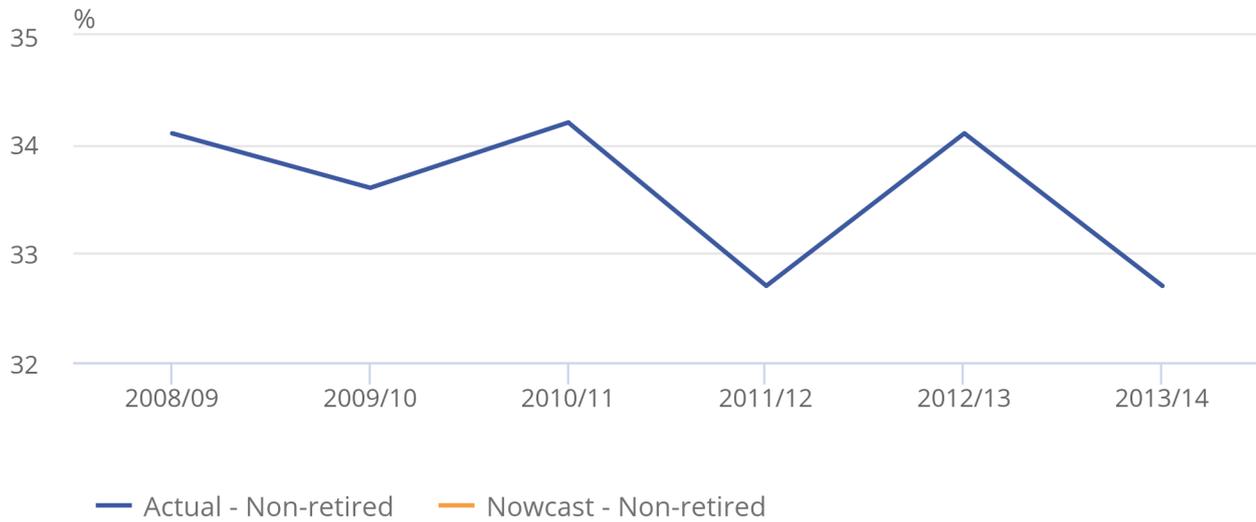—— Actual - All households —— Nowcast - All households

Notes:

1. Households are ranked by their equivalised disposable incomes, using the modified-OECD scale

2. 95% confidence intervals included (not visible on the graph due to scaling)

Figure 4ii: Gini coefficients 2008/09 to 2013/14

Non-retired households

Figure 4ii: Gini coefficients 2008/09 to 2013/14

Non-retired households

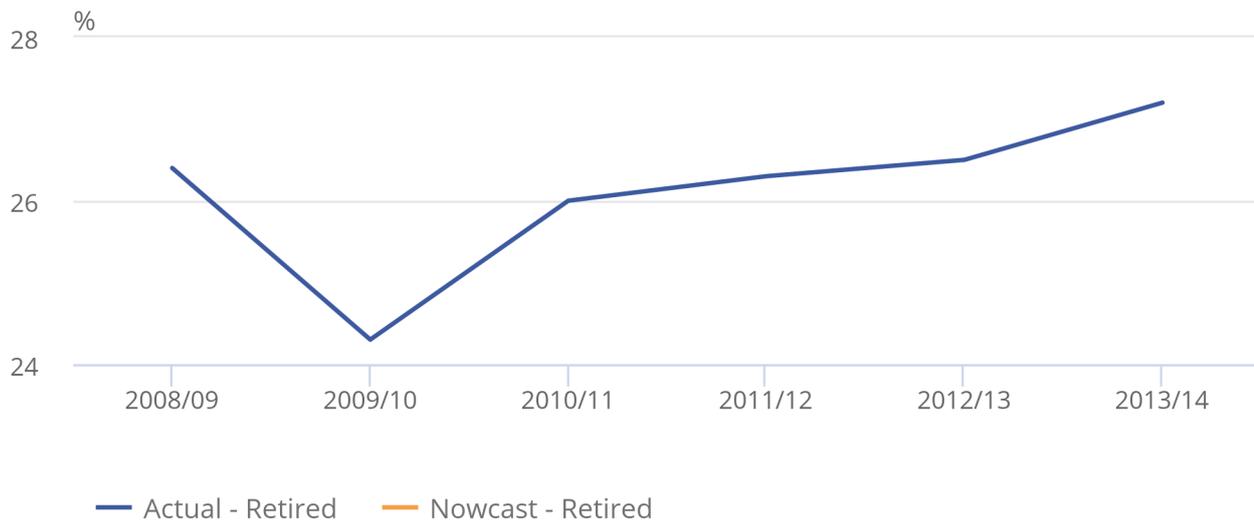Actual - Non-retired   Nowcast - Non-retired

Notes:

1. Households are ranked by their equivalised disposable incomes, using the modified-OECD scale

2. 95% confidence intervals included (not visible on the graph due to scaling)

Figure 4iii: Gini coefficients 2008/09 to 2013/14

Retired households

Figure 4iii: Gini coefficients 2008/09 to 2013/14

Retired households

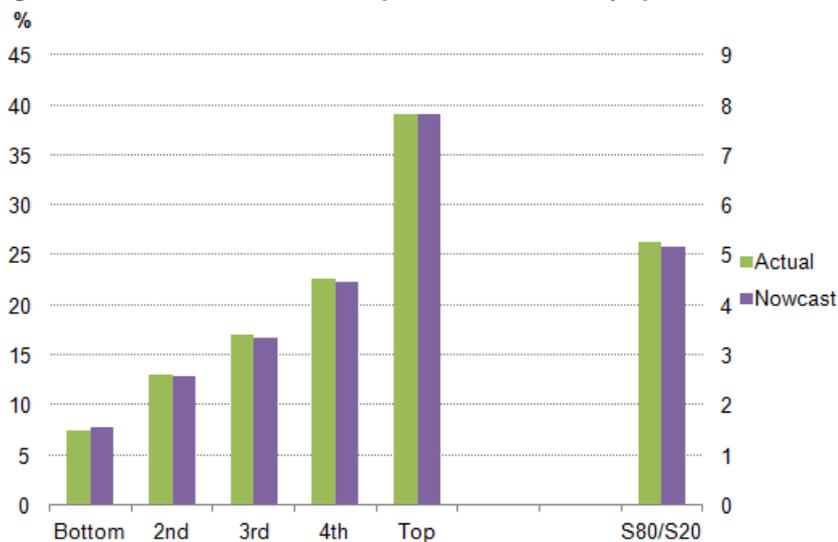Legend: Actual - Retired, Nowcast - Retired

Notes:

1. Households are ranked by their equivalised disposable incomes, using the modified-OECD scale

2. 95% confidence intervals included (not visible on the graph due to scaling)

Figure 5 contains two other inequality measures, the share of equivalised disposable income for each quintile group and the S80/20 ratio, presenting both nowcasts and published ETB estimates. It shows that nowcasting estimates are very closely aligned with published 2013/14 income data on both measures.

Figure 5: Shares of median disposable income by quintile and S80/S20 shares, all households, 2013/14

4 . Conclusion and next steps

There is clear user demand for more timely data on the distribution of household income. Although there are measures such as RHDI available from the National Accounts on a quarterly basis, these data only provide national totals or (mean) per capita measures. As highlighted in the introduction, in order to properly understand changes in material living standards, it is important to have measures which reflect the experience of the typical household and can also provide a description of the distribution. The key issue is therefore whether nowcasting as an approach can provide sufficiently robust early or provisional estimates of relevant indicators, significantly ahead of the full data from the Effects of Taxes and Benefits on Household Income becoming available.

The aim of the work underlying this methodological paper was therefore to develop an initial nowcasting methodology and assess the appropriateness of using this approach to produce more timely indicators of income distribution for UK households. As a demonstration of this method, disposable income estimates were calculated and their quality assessed against actual data. The microsimulation model IGOTM was used to simulate policy reforms and update incomes accordingly. A re-weighting approach was employed to account for labour market and demographic changes.

In order to ensure a rigorous test of the methodology, the data used to produce the nowcasts was several years older than the latest available, meaning that the period for which nowcasts were produced (2013/14) was a number of years ahead of the base data. Despite that additional challenge, overall, the nowcast estimates produced are very similar to the survey based estimates, with the all households estimates of median and mean equivalised disposable income, the Gini coefficient and the S80/20 ratio all extremely close to those values reported in the Effects of Taxes & Benefits on Household Income. As a rough guide to their accuracy, it is promising that the confidence intervals of all these nowcast estimates overlap the published figures. As stated in the discussion of the results, the nowcast figures for retired households were less close to the published estimates, due to growth in income from private pensions being lower in the nowcast figures, highlighting the need for further refinements to the methodology.

The accuracy of any nowcast will depend on many factors. Among them are the choice of uprating indices, the accuracy with which the microsimulation techniques reflect the impact of tax and benefit changes and the control totals used to re-calibrate original weights. Throughout the work feeding into this technical note, we have tested a variety of approaches and variants in order to develop a robust methodology and have sought to learn from others expert in this field.

It is, of course, unrealistic to expect nowcast estimates to perfectly reflect changes in the distribution of income, particularly when examining smaller subgroups of the population. While the use of a tax-benefit microsimulation model allows us to simulate the distributional effect of changes to the tax-benefit system with a relatively high degree of accuracy, some aspects remain that may be oversimplified. For example, certain income sources may follow different trends during periods of crisis and exhibit different patterns across regions. This could lead to discrepancies between nowcast and actual income dynamics and should be taken into account when interpreting the results. Additionally, while the calibration takes account of changes in the labour market and demographic structure of the population, no similar adjustments are made for changes in the composition of households. However, considering the relatively short time frame being examined, such changes are likely to be less critical for the purpose of this analysis. It should also, of course, be noted that the main survey-based distributional data are also estimates, with sampling error and various sources of non-sampling error associated with them.

While nowcasting may be subject to some limitations, it has the benefit of producing timely estimates of household income and thus the potential to facilitate monitoring of the effects of recent changes in economic policies. Nowcasting is a more reliable approach than forecasting as it combines actual data for components that are known. The evidence suggests that it may be a sound approach for producing early estimates of key income indicators while waiting for survey based estimates to become available.

Next steps

ONS therefore intend to continue to revise and enhance the methodology presented in this paper over Summer 2015. In particular, we will:

- update the base data used to a more recent reference period

- consider ways to better account for changes in income from private pensions

- consider whether to introduce additional calibration constraints such as full-time/part-time employment

- examine the use of nowcasting to produce rates of growth/change rather than point estimates

We are also keen to use the methodology and results presented in this paper in order to discuss next steps with those with expertise in nowcasting and potential users of these estimates. In particular we are keen to receive feedback on the methodology and ways in which it can be enhanced and refined. We also wish to receive views on which early/provisional indicators users would find most useful.

Feedback is welcome at any time, but any received by 30 July 2015 will be particularly helpful. Please contact Richard Tonkin (richard.tonkin@ons.gsi.gov.uk or 01633 456082).

Based on the content of this feedback and following completion of the next stage of methodological work, we intend to publish nowcast based early estimates for 2014/15 indicators later this year, badged as "Experimental Statistics". Future publication plans will be subject to user feedback received and the results of the methodological work. However, in future years, based on the current methodology, it should be possible to publish nowcast estimates within a few months of the end of the income reference period, i.e. estimates for 2015 /16 by July 2016.

Based on the content of this feedback and following completion of the next stage of methodological work, we intend to publish nowcast based early estimates for 2014/15 indicators later this year, badged as "Experimental Statistics". Future publication plans will be subject to user feedback received and the results of the methodological work. However, in future years, based on the current methodology, it should be possible to publish nowcast estimates within a few months of the end of the income reference period, i.e. estimates for 2015 /16 by July 2016.

5. Technical annex

Variable uprating

Most of the variables are updated before IGOTM is run, with the exception of household consumption and expenditure on fuel and power, which are uprated in IGOTM itself. All the variable uprated are grouped into 12 categories, so there are 12 different sets of uprating variables as shown in Table 1 below.

Chart unavailable

Re-weighting

As a standard procedure across the majority of ONS surveys, the LCF is calibrated to known population totals for region and age/sex groups. These population totals come directly from projections taken from the most recent Census, which are constantly updated with reliable information derived from birth and death counts, migration rates and immigration counts.

The LCF data are weighted at household level where the design weights represent the inverse probability of selection of a household. The weights are then adjusted to reduce bias from non-response, using scaling factors developed from information taken from the Census Non-Response Link Study (CNRLS). These design weights are then fed into Generalized Estimation System (GES), which adjusts the weights of each household, using information on the region of the household and the age and sex of household members (the latter often gathered by proxy). This calibration process uses known information to improve representiveness of the estimates across these groups. Re-calibration of the existing weights involves using updated control totals and an additional constraint – economic status.

The new weights are calibrated to the population totals of the following 12 regions:

1. North East

2. North West

3. Merseyside

4. Yorkshire and Humberside

5. East Midlands

6. West Midlands

7. London

8. South East

9. South West

10. Wales

11. Scotland

12. Northern Ireland

The following sex/age groups:

1. Male 0-4

2. Male 5-9

3. Male 10-15

4. Male 16-19

5. Male 20-24

6. Male 25-29

7. Male 30-44

8. Male 45-54

9. Male 55-64

10. Male 65-74

11. Male >75

12. Female 0-4

13. Female 5-9

14. Female 10-15

15. Female 16-19

16. Female 20-24

17. Female 25-29

18. Female 30-44

19. Female 45-54

20. Female 55-64

21. Female 65-74

22. Female >75

And the following employment groups:

1. Self-employed

2. Full-time & part-time employed

3. Unemployed & work related Government Training Programmes

4. Retired/unoccupied and of the minimum NI Pension Age & Retired/unoccupied below the minimum NI Pension Age

5. Under 16

6. Background notes

1. **Related Statistics**

   The Effects of Taxes and Benefits on Household Income

   A guide to sources of data on earnings and income (653.5 Kb Pdf) - Provides a detailed comparison of sources of income and earnings data

2. **References**

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