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Evaluating the results of a social benefit simulation using individual administrative data on benefit receipt

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Abstract The simulation of social benefit entitlements is an important application of tax-benefit microsimulation models in social policy research. However, the simulation of social benefits that include a comprehensive means test and overlap with other social benefits is subject to numerous data limitations and simulation inaccuracies. This note examines the validity of the results of an open-source tax-benefit microsimulation model (GETTSIM) on social benefit entitlements. We use accurate administrative data collected during the application process for the simulation to assess the quality of the simulation. We find a low beta error rate and a high match between simulated and recorded benefits, making GETTSIM a powerful tool for the analysis of social policies.
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1. Introduction

The simulation of social benefits is an important application of tax-benefit microsimulation models in social policy research. Simulation outcomes inform about the effects of social policies on macroeconomic variables, such as the income distribution or public budgets. Analogously, the potential effects of policy reforms can be simulated and examined. Furthermore, tax-benefit simulations allow for an evaluation of the interactions of different benefits in often complex social benefit systems. In this way, they contribute to the evaluation of the effectiveness and efficiency of social policies. However, the quality of the simulation outcomes has consequences for the assessment of the effectiveness of the benefit system. For example, an increasing number of recent studies on benefit non-take-up as one measure for the ineffectiveness of social policies explicitly address the difficulties in determining benefit entitlements using tax-benefit microsimulation models, as the level of measured benefit non-take-up also depends on the quality of the data (***Tasseva, 2016***; ***Bruckmeier et al., 2021***; ***Doorley and Kakoulidou, 2024***), and on the quality of the simulation (***Bargain et al., 2012***; ***Harnisch, 2019***).

Consequently, the validation of the simulation outcomes to ensure reliable and relevant results is an important step in the application of tax-benefit simulations. In a macrovalidation simulation outcomes could be validated against aggregated figures from official statistics. In addition, the distribution of the simulated net earnings or disposable income can be compared with external statistics on the income distribution (***Sutherland and Figari, 2009***; ***Richiardi and Collado, 2021***). Other validation approaches could focus on individual deviations, the quality of the underlying data or compare the outcomes of different simulation models for a common set of households (***Jara and Oliva, 2018***; ***Hufkens et al., 2016***; ***Siebertova et al., 2016***).

Especially when simulating social benefit entitlements in complex social policy systems, there are numerous potential reasons for inaccurate simulation outcomes. Typically, the information necessary for a comprehensive means test is not available in survey data originally collected for various purposes. Missing or inaccurate information in the data as well as complex regulations make it necessary to rely on assumptions for the simulation of eligibility. Even when using unbiased data with minimized

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measurement errors, benefit simulation results may be inaccurate. For example, design-related features of the benefit programme such as the interplay with other benefit programmes can lead to incorrectly simulated entitlements as well as incorrectly simulated missing entitlements. Hence, the quality of the simulation not only depends on the extent of measurement errors in the data, but also on modelling issues.

With this paper we contribute to the literature on validating the results of tax-benefit simulation models. We examine how well the results of an open-source tax-benefit microsimulation model for Germany (GETTSIM) on means-tested minimum income (UBII) entitlements match the benefits contained in administrative data on UBII. Our analysis has two objectives: First, the results should provide an assessment of the validity of the UBII simulation results using GETTSIM. Second, generalized conclusions for policy and non-take-up analyses based on tax-benefit microsimulation models will be drawn.

The administrative data in our study are collected from the local job agencies responsible for the administration of UBII. In contrast to most benefit simulation studies, the input variables on socio-demographic characteristics as well as financial information on income for the simulation come from the administrative processes. The administrative data is provided in the UBII application process and used by the local job agencies to calculate the UBII entitlement. On the basis of this accurate data, the typical measurement errors of survey data, such as the over- or underreporting of income, can be avoided. Furthermore, the data reference period for the variables in our data refers to months, which is also the basis for calculating the benefit entitlement. This means that time-period issues that lead to simulation errors should also be minimized. Remaining inaccuracies in the benefit simulation could occur for different reasons. Examples are discretionary decisions in the means test, information not considered in the simulation, or specific complex life circumstances that cannot be represented in the syntax of the simulation model. Furthermore, since GETTSIM also simulates entitlements to other social benefits, simulation errors that arise from the complexity of the benefit system and the interaction or overlap of different benefits also become visible.

Our analysis considers three concepts of validation. First, we examine how often the simulation correctly simulates UBII entitlements in general. The proportion of observations without simulated entitlements among all households corresponds to the beta error reported in the literature on benefit non-take-up and is usually used as a measure of simulation quality. Second, we compare the distribution of simulated and recorded claims in a macrovalidation, which is particularly important for policy analyses. Third, we examine deviations from the recorded entitlements at the individual level.

The paper is structured as follows: section 2 provides a brief description of the UBII benefit system. In section 3, we describe our data and the sample selection for the analysis. Section 4 introduces the tax-benefit microsimulation model GETTSIM and documents the used variables and data cleaning steps required for the simulation with GETTSIM. We then examine the simulation results with regard to deviations from recorded data in eligibility, the distribution of simulated UBII benefits and deviations in individual entitlements in section 5. Finally, we discuss the implications for policy analysis using GETTSIM and benefit simulations in general in section 6.

2. Institutional background

Our analysis focuses on the simulation outcomes for the entitlement to unemployment benefit II (UBII), introduced in Germany in 2005. In 2023 it was renamed “Citizen’s Income”, but since the data used in this study covers a period before 2023, the term “UBII” is used throughout. UBII is the most important means-tested social benefit in Germany with around 5.5 million recipients in 2024. It ensures the minimum income for employable persons and their households. The benefit is means-tested and assets-tested, with virtually all types of income and assets being considered when assessing eligibility. In addition, the benefit is granted conditionally on job-search and take up of employment. Some groups are exempted from work obligations, for example because they care for children or are in the education system. Note that unemployment is not a necessary requirement and recipients may live in very different circumstances, for example as low-wage earners, long-term unemployed, carers of relatives, or self-employed.

The total cash UBII benefit always relates to the household and consists of several components: standard benefits to cover living costs for each family member and individually calculated benefits for housing and heating costs. In addition, UBII recipients are covered by health insurance. Finally, UBII may grant additional cash benefits for special needs. For example, single parents can receive an extra monthly benefit up to 60 percent of the standard benefit to cover living costs. Additionally, other benefits for special life circumstances and needs exist (for example during pregnancy). In 2024, the nationwide uniform benefit to cover the cost of living for a single person amounted to 563 Euros per month. Benefits for partners and children are lower and age-dependent. The costs of accommodation and heating costs are fully covered, but only if they are appropriate in comparison to average costs in the region. The net income of all household members is deducted from total needs, with an individual allowance for earned income.

One advantage of tax-benefit microsimulation models is that the entire system of social benefits is considered in the analysis. This is particularly important in the case of the UBII simulation as there are interdependencies with two other important benefits, Housing Benefit (HB) and the means-tested Child Benefit (CB). The receipt of HB and the CB excludes the simultaneous receipt of UBII, but HB and CB can be claimed simultaneously. These two benefits target households with low (wage) income that is, however, significantly above the UBII minimum income. The aim is to enable low-income earners to avoid receiving UBII by receiving these two upstream benefits. ***Figure 1*** illustrates the interaction of these three benefits for the example of a family with a minor child. The transition between the different benefit systems is determined by individual conditions, for example the amount of housing costs and the composition of the household. Households cannot claim UBII if the combined entitlement from HA and CA exceeds the UBII entitlement, while HA is only granted if the income of a household including the HA is at least 80 percent of the total UBII needs. This is intended to prevent households receiving HA from living substantially below the minimum income determined by UBII. Although it is possible to receive HA even if the resulting household income is slightly below the household's need as defined by the UBII, microsimulation models typically assume that households are only eligible for housing benefit and means-tested child benefit if the combined amount of these two benefits exceeds the UBII entitlement. This is shown in ***Figure 1***, which also shows the hypothetically calculated amount of HB and CB if UBII is more financially advantageous (shaded area).

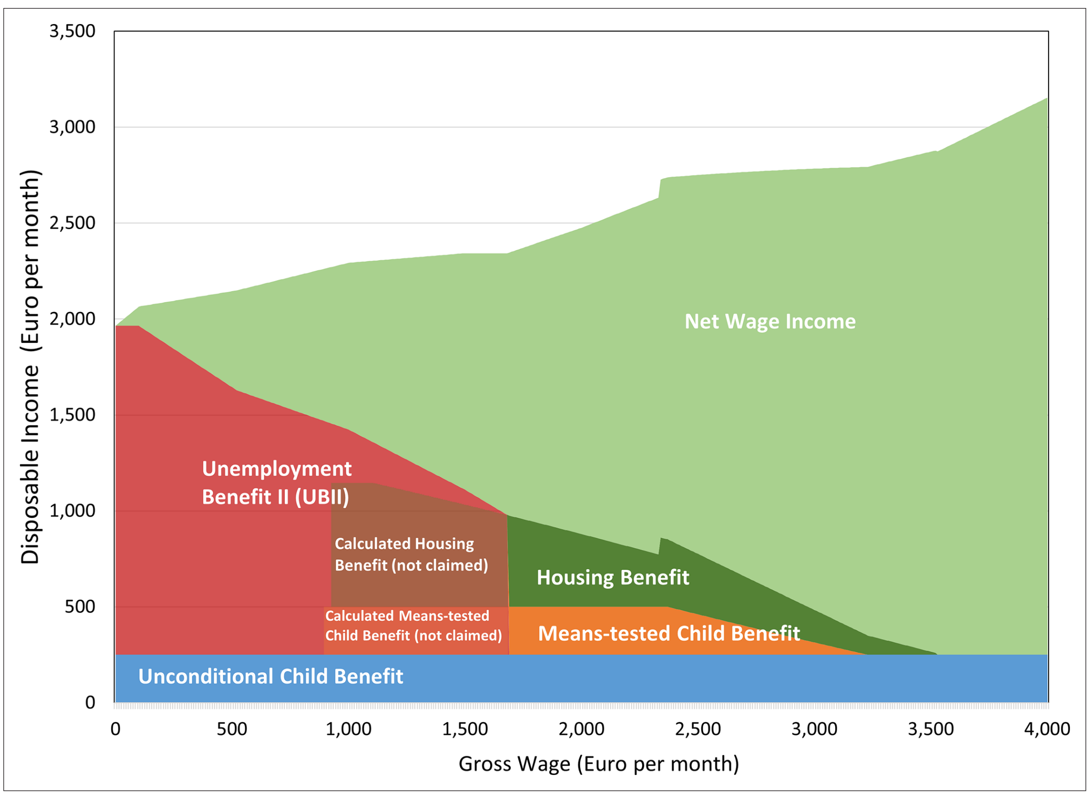

Figure 1 Unemployment Benefit II (UBII), Housing Benefit (HB) and Child Benefit (CB) for a single-earner couple household with one minor child (2023).

Source: Microsimulation model of the IAB (IAB-MSM).

With standardized benefit levels for living costs (B) and special needs (BS), reported housing costs (HC) and clear rules for calculating the deductible household income (Y), the simulation of UBII with tax-benefit microsimulation models seems straightforward. However, due to the interplay with Housing Benefit (HB) and means-tested Child Benefit (CB), the calculation of UBII becomes more complex because potential entitlements to the two prioritized benefits must be considered when calculating UBII. In order to differentiate between benefits, existing tax-benefit models for Germany typically assume that the household is entitled to the maximum payment, with HA and CB considered together:

$$Entitlement = \max\left[0; \left(B + BS + HC\right) - Y; \left(HB + CB\right)\right] \quad (1)$$

The brief summary of the institutional features illustrates that the simulation of UBII could be challenging. A lot of information is required due to the comprehensive means test, and discretion regarding the accepted HC as well as special individual circumstances not considered in B or BS may lead to wrong simulation outcomes. Furthermore, the distinction between the three different benefits can become complex and, in reality, may contain a certain degree of randomness due to, for example, locally different cooperation between the authorities responsible for the three different benefits.

3. Data and validation sample

Our analysis builds on a 2 percent randomly drawn sample of UBII recipients processed in the Sample of Integrated Welfare Benefit Biographies (SIG, version 0720) of the Institute for Employment Research (IAB) (***Dummert et al., 2022***). The information in the data is based on consolidated individual daily information from the administrative procedures of the local authorities responsible for UBII. This data contains personal characteristics of the recipients and daily information on UBII receipt. Our UBII sample is linked to other data from the administrative processes. For our analyses, this is in particular information about the other members of the household, which are also considered when calculating the benefit entitlement (members of the "benefit unit"), as well as all financial data from the benefit calculation process. The financial information is accurate to the month, with the information on the 15th of each month used to measure the characteristics of the recipient and the household. The financial data contain information on the households' needs (the potential entitlement before income is deducted), the income considered in the means test, and the actually paid out UBII benefit. For our analysis, we use all the months of the years 2017 and 2018 (see ***Table 1***). We focus on recipients between 25 and 64 years old and also drop a few observations because no adult is part of the benefit unit, for example because the household only receives UBII for special needs of children. In addition, we exclude observations from the analysis sample for which it is assumed that no valid simulation is possible. The main reason why entitlements cannot be accurately simulated is missing values in necessary variables (60 percent). Furthermore, no valid simulation can be carried out if benefit recipients live in a household with people who are excluded from UBII entitlements (36 percent), for example pensioners, because the data contains no reliable income information for people who are not entitled to UBII. With this last selection step another approximately 9 percent of the observations are excluded from the simulation sample. ***Table A1*** in the appendix shows the distribution of key characteristics of the simulation sample and the observations that are excluded in this final step. Small differences between the two groups are evident in terms of age, living in East Germany, having no school qualification or non-German nationality. Female recipients are slightly underrepresented among the excluded observations compared to the simulation sample. Significant differences emerge between the household structure of included and excluded households. Children live in almost all excluded households (95 percent), either in couple households or with single parents. A closer inspection of the data shows that more than 50 percent of the excluded single parents have children above 18 years and younger than 25 years old, which also applies to almost all excluded couple households (97 percent). The final selection step therefore might slightly distort the representativeness of our simulation sample with regard to households with children in this specific age group.

Table 1. Sample selection.

	2017 Individuals	2017 Observations	2018 Individuals	2018 Observations
UBII recipients	152,266	1,492,013	145,126	1,432,790
⁒ recipients <25 or >64 years old	87,459	848,561	82,833	810,684
⁒ only children in the household registered	87,145	844,708	82,531	806,966
⁒ no valid simulation possible	79,124	730,964	74,672	696,506
= analysis sample	79,124	730,964	74,672	696,506

Source: SIG version 0720, own calculations.

We finally end up with a 731 thousand person-month-observations for the year 2017 and a 697 thousand person-month-observations for the year 2018 that enter the simulation model.

4. Simulation model and data preparation

The simulation of the UBII entitlements is based on the German Taxes and Transfers Simulator (GETTSIM), an open-source static tax-benefit microsimulation model. The development of GETTSIM is led by researchers from the University of Bonn with contributions by colleagues from the ifo Institute, DIW, ZEW, IAB, and others. It has received funding by the German Research Foundation (DFG). Our simulation is based on the latest stable GETTSIM version v0.7.0. GETTSIM simulates the most important parts of the German tax and benefit system, such as income taxes, social security contributions, child benefit and means-tested child benefit, housing benefit and UBII. GETTSIM is implemented in Python. The model code, the code documentation, and other information on using GETTSIM are available online.[1] The goal of GETTSIM is to develop a microsimulation tool that can be used by many researchers with different data to investigate different research questions. GETTSIM is therefore data agnostic and can in principle be applied to data from different sources, as long as the input variables satisfy the documented definitions. The administrative data we use follows the logic of legal provisions and was collected for a specific purpose, namely the calculation of UBII benefits. Therefore, several steps or assumptions are necessary for preparing the required input variables for the simulation, which is explained in the following.

When assessing eligibility, only the needs and income of the members of the core family are considered in the means test (see section 2). Our data always refers to the family members relevant for the benefit calculation, thus inaccuracies when defining communities of needs (i.e., the core family in most cases) within a household are avoided. We distinguish between three approaches to data preparation to generate the necessary input variables for the simulation (see ***Table 2***): First, the existing variables in our dataset can be used directly or in transformed form (E). Second, a new variable is derived or approximated from existing information (D). An example is assets considered in the means test. Although there is no information on assets in the data, all individuals in our sample are entitled to UBII and have therefore passed the asset test. The assets are therefore set to 0 so that no individual fails the assets test in the simulation. In the third approach, input variables for the simulation are generated by setting assumptions because no information is available in the data (A). An example is the tax unit ID. For the calculation of income tax, it is important to know whether the taxpayer has children. For unmarried couples, each partner receives their own tax ID. In the case of children living in the household of an unmarried couple we do not know which partner the children belong to. In this case they are assigned randomly between the two partners.

Table 2. Data preparation for the simulation.

Input variable	Label	Source	Information used in SIG data, data transformation, assumption
hh_id	Household identifier	E	Number of the benefit unit

Input variable	Label	Source	Information used in SIG data, data transformation, assumption
tu_id	Tax Unit identifier	D/A	Singles, single parents and couples with married head of household and partner: tu_id equals hh_id. Couples with at least one unmarried partner, the head of household and partner receive a separate tu_id and children in the household are randomly assigned to one of the two tu_ids. Calculation based on marital status and type of benefit unit.
p_id	Person identifier	E	Unique personal identifier
kind	Dummy: Dependent child living with parents	E	Position in the benefit unit
bruttolohn_m	Monthly gross wage	E	Monthly gross wage considered in the means test
alter	Individual's age.	E	Age
weiblich	Dummy: female	E	Gender
rentner	Dummy: Pensioner employment status	E	Reason for exclusion from SGB II
alleinerz	Dummy: Single parent	E	Type of benefit unit
wohnort_ost	Dummy: Living in former East Germany	E	Place of residence
in_priv_krankenv	Dummy: In private health insurance	A	Assumption that there is no private health insurance.
priv_rentenv_beitr_m	Monthly private pension contribution	A	Set to 0, assumption that there is no private pension insurance.
in_ausbildung	Dummy: Employment status "in education"	D	In vocational training or eligible for training assistance.
selbstständig	Dummy: Self-employed (main profession)	D	Set to 1 if income from self-employment is considered in the means test
hat_kinder	Dummy: Has kids (incl. not in hh)	D/A	Type of benefit unit, assumption: no children outside the household
betreuungskost_m	Monthly childcare expenses for a particular child under the age of 14	A	Set to 0
sonstig_eink_m	Additional income: includes private and public transfers that are not yet implemented in GETTSIM (e.g., BAföG, Kriegsopferfürsorge)	E	Other income considered in the means test (public and private transfers)
eink_selbst_m	Monthly income from self-employment	E	Monthly gross income from self-employment considered in the means test
eink_vermietung_m	Monthly rental income net of deductions	E	Monthly disposable rental income considered in the means test
kapitaleink_brutto_m	Monthly capital income	E	Monthly disposable capital income considered in the means test
bruttokaltmiete_m_hh	Monthly rent expenses for household	E	Accepted regular monthly gross rent including additional costs (excluding heating costs)
heizkosten_m_hh	Monthly heating expenses for household	E	Accepted regular monthly heating costs
wohnfläche_hh	Size of household dwelling	A	45 sqm for first person plus 15 sqm for each additional member
bewohnt_eigentum_hh	Dummy: Owner-occupied housing	A	No home ownership
arbeitsstunden_w	Weekly working hours of individual	A	Set to 0

Input variable	Label	Source	Information used in SIG data, data transformation, assumption
geburtstag	Day of birth	E	Day of birth
geburtsmonat	Month of birth	E	Month of birth
geburtsjahr	Year of birth	E	Year of birth
jahr_renteneintr	Year of retirement	D/A	Year of birth +65
m_elterngeld	Number of months hh received elterngeld	A	Set to 0
m_elterngeld_vat_hh	Number of months father received elterngeld	A	Set to 0
m_elterngeld_mut_hh	Number of months mother received elterngeld	A	Set to 0
behinderungsgrad	Handicap degree (between 0 and 100)	A	Set to 50 if person is severely disabled, else set to 0
schwerbeh_g	Severely handicapped, with flag "G"	E	Set to 1 if person is severely disabled
mietstufe	Level of rents in city (1: low, 3: average)	E/A	Merged to dataset based on the municipality number of the place of residence, missing values are assigned to level 3
immobilie_baujahr_hh	Construction year of dwelling	A	Set to 2000
vermögen_bedürft_hh	Assets considered for means testing	A	Set to 0
entgeltp	Earnings points for pension claim	A	Set to 0
priv_rente_m	Amount of monthly private pension	A	Set to 0
bürgerg_bezug_vorj	Received Bürgergeld in previous year	A	Set to 1
kind_unterh_anspr_m	Monthly gross child alimony payments as determined by the court	D	Maintenance payments (for children and a spouses) considered in the means test
kind_unterh_erhalt_m	Monthly actual child alimony payments	D	Maintenance payments (for children and a spouses) considered in the means test
steuerklasse	Tax Bracket (1 to 5) for withholding tax		
jahr		E	Year of recorded benefit receipt
Specified output variables			
unterhaltsvors_m	Alimony advance payment	E/A	Set to 0 (included in kind_unterh_erhalt_m)
veink_algI	Monthly amount of unemployment insurance benefit	E	Unemployment insurance benefit considered in the means test
ges_rente_m	Total private and public pension	E	Pension payments considered in the means test (public and private)

Source for the variable name and description: https://gettsim.readthedocs.io/en/stable/gettsim_objects/input_variables.html [accessed September 23, 2024]. E=Existing variable used or transformed, D=New variable derived/approximated from available information, A=New variable generated by assumption. Specified output variables are variables that can be simulated, but were specified as input variables in our analysis and hence not simulated.

Table 2 gives an overview of the input variables used (original variable names used in GETTSIM) and the data preparation steps required to generate the input variables. Most variables can either be obtained directly from the data, such as most income data, or derived from available information. Variables for which assumptions are necessary have, on the one hand, no quantitative significance among

UBII recipients, such as contributions to private health insurance or homeownership. On the other hand, most assumptions have no effect on the simulation of the UBII entitlement, since they are made for variables that are necessary for the simulation of other entitlements, such as pension payments (not relevant for the UBII sample) or parental leave benefits (these benefits are directly measured in the "other income" variable in the data). In summary, simulation errors resulting from missing or inaccurate information in the database should be of little relevance.

For our study, we make three adjustments to the code of GETTSIM in version v0.7.0 that are particularly important for the simulation of UBII. First, we present the simulation results for the GETTSIM version v0.7.0 (variant GETTSIM). In a first adjustment, we remove the limit on the maximum rent paid with the UBII benefit, since our data allow us to measure the rent accepted by the local UBII authorities (variant NoRentLimit). By adjusting the housing cost cap implemented in GETTSIM, the recipient's rent recorded in the data is always fully taken into account in the simulation, since we know that this exact amount was paid to the recipient. In a second adjustment, we additionally implemented the rule that households can only receive HA if the sum of their income and the potential HA entitlement is at least 80 percent of the UBII needs (variant HAStricter1). This rule implies that HA recipients may also be worse off financially than if they were receiving UBII. This regulation leaves local authorities with discretion, and 90 or 100 percent can also be implemented. In the latest unreleased development version of GETTSIM, the rule is implemented with 100 percent, and for this reason, we include the implementation of the rule with 100 percent as a last third variant in the analysis (variant HAStricter2).

5. Results

5.1. Beta error rate

The "type II error" or "beta error" is a widely used measure to assess the validity of a benefit simulation and the relevance of measurement error. In studies mostly using survey data, households are classified as "beta errors" if they are simulated as not being eligible for a particular benefit but report receipt of that benefit in the survey (***Goedemé et al., 2022***; ***Harnisch, 2019***; ***Sutherland et al., 2009***; ***Frick and Groh-Samberg, 2007***). Several reasons can lead to beta errors. One explanation is fraud caused by underreporting of income to the local benefit authorities. If the correct income is reported in the survey, no entitlement would correctly be simulated, even though the respondents are receiving benefits. Since only the income recorded in the UBII administration is included in our benefit simulation, this type of interpretation is not relevant in our case. Another reason could be errors in the calculation of the entitlement by the administration, which erroneously lead to an entitlement, which seems to be of little importance. Last, entitlements could be simulated imprecisely, resulting in individuals being erroneously considered as not entitled to UBII. The reasons for this misclassification lie primarily in the benefit system itself and depend on its complexity and specificity. For example, when determining the UBII entitlement, it is at the discretion of the local authorities whether, in the case of high accommodation costs, the full costs are covered by the UBII payments. The decision depends, among other things, on the alternatives on the local housing market. Such regional or even individual variations cannot be considered in the simulation.

Table 3 shows the result of the UBII entitlement simulation produced by GETTSIM and the different simulation variants. Entitlements are correctly simulated for around 91 percent of all monthly observations with GETTSIM. The proportion of misclassified observations, the beta error rate, amounts to 9.34 percent. Compared to a beta error rate of 17.41 percent for UBII, which Harnisch (2019) reports based on a simulation using survey data (SOEP), this value is rather low. In comparison to the findings for other benefits in different welfare systems, the beta error rate is of a comparable magnitude (***Goedemé et al., 2022***; ***Sutherland et al., 2009***). However, given that our simulation uses data that is collected during the UBII application process that is not contaminated by measurement errors typical of survey data, the beta error rate is surprisingly high. ***Table 3*** provides more information about the reasons for the lack of simulated claims. For the beta error observations, it shows which other transfer payments that have priority over the UBII benefits were simulated. These results provide an indication of the reasons for the lack of simulated UBII entitlements. For the vast majority of observations with missing UBII entitlement an entitlement to the means-tested housing and child benefits (72.95 percent) or housing benefits only (23.17 percent) is simulated. For 3.27 percent or less than 3,000 observations, no entitlement to any of the three benefits is simulated. The three adjusted simulation variants all show a higher precision in determining a UBII claim. The beta error is reduced to 8.95 percent (NoRentLimit), 3.68 percent (HAStricter1) and 2.88 percent (HAStricter2). It also becomes evident that the more precise differentiation between the two benefits UBII and HA in the simulation variants HAStricter1 and HAStricter2 leads to a significantly better simulation quality expressed in a lower beta error rate. For the last two variants, there are significantly fewer observations where HA or an HA and CB was simulated instead of a UBII claim.

Table 3. Simulated versus registered UBII entitlement (shares in percent).

	GETTSIM	NoRentLimit	HAStricter1	HAStricter2
All observations	100.00	100.00	100.00	100.00
with simulated UBII entitlement	90.66	91.05	96.32	97.12
without simulated UB II entitlement (beta error)	9.34	8.95	3.68	2.88
thereof:				
simulated housing and child benefit	72.95	74.64	18.05	0.01
simulated housing benefit only	23.17	21.72	23.80	4.26
simulated child benefit only	0.61	0.59	44.03	68.68
none	3.27	3.04	14.12	27.05

Notes: Beta-error results refer to 1,427 thousand person-month-observations that enter the simulation in each simulation variant.
Source: SIG version 0720, GETTSIM v0.7.0, own calculations.

5.2. Distribution of recorded and simulated UBII entitlement

In the following, we compare the distribution of the recorded and simulated UBII entitlement. The results for the simulated entitlement refer only to households with a positive entitlement in the respective variant. The recorded UBII entitlement includes the standard benefit for living costs, the benefit for the monthly accepted housing and heating costs and the additional benefits for special needs.

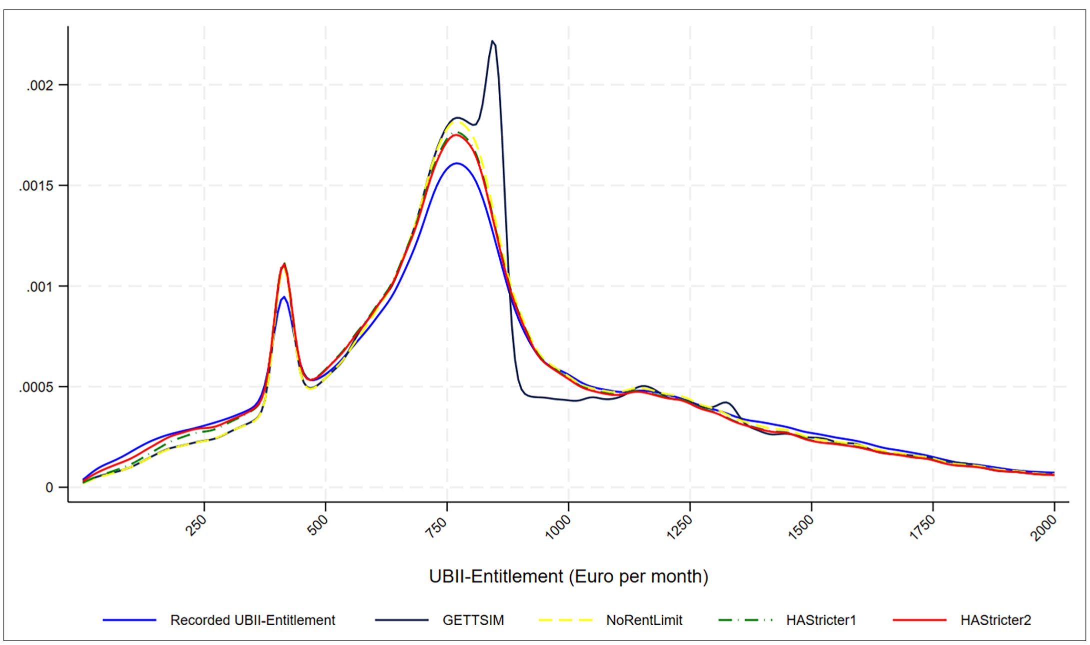

Figure 2 Distribution of the monthly simulated and recorded UBII entitlements.

Source: SIG version 0720, GETTSIM v0.7.0, own illustration.

Figure 2 shows the kernel density estimates for the distribution of the simulated and the recorded UBII entitlements. While the distributions are basically very similar, the result of the GETTSIM variant shows a clear anomaly, which indicates a censoring of certain values. The difference between the variants GETTSIM and NoRentLimit shows that the censoring of the rent, which is considered in the calculation of housing needs in the means test, leads to this censoring and significantly worsens the adjustment of the simulation result to the distribution of the recorded benefits. The three adjusted variants, however, show a similar bimodal distribution of the recorded entitlements, with the first peak at approximately 413 Euro which is the average of the standard benefit for singles in 2017 and 2018. If single people, such as children older than 24 years, live rent-free with their parents, they usually receive exactly this amount.

Table 4 takes a closer look at different points of the distributions. Since the tax-benefit simulation cannot reflect all UBII components (i.e., payments in special circumstances), the average entitlement in all simulation variants is below the recorded entitlement of 891 Euro per month. As expected, the variation of the distribution of the entitlement recorded in the administrative data is also higher than that achieved in all simulation variants, as shown by the higher standard deviation. One reason for this could be discretionary decisions in the calculation of benefits by local authorities, which cannot be reflected in the general calculation rules in the simulation.

Table 4. Mean, standard deviation and quantiles of the distribution of recorded and simulated UBII.

	Recorded UBII-entitlement	GETTSIM	NoRentLimit	HAStricter1	HAStricter2
Mean	891	873	882	865	859
Std. deviation	500	417	427	427	430
0.1 quantile	390	413	415	409	404
0.5 quantile	796	794	796	786	784
0.9 quantile	1,515	1,456	1,465	1,447	1,444
N (in thousands)	1,427	1,294	1,300	1,375	1,386

Source: SIG version 0720, GETTSIM v0.7.0, own calculations.

In terms of the average entitlement, the smallest difference compared to recorded entitlements is found for variant NoRentLimit (891 Euro versus 882 Euro). The lack of censoring of housing costs in this variant compared to GETTSIM significantly improves the adjustment. Deviations increase for variant HAStricter1 and HAStricter2 with mean values of 865 and 859 Euros. The more precise distinction between HA and UBII in variants HAStricter1 and HAStricter2 leads, on the one hand, to more households correctly being allocated to UBII, but on the other hand it reduces the average UBII entitlement, since households in the income area of UBII, HA and CB have lower UBII entitlements than households without any own income. Accordingly, variant HAStricter2 has also the lowest quantile values. However, if one simply extrapolates the annual UBII expenditure based on the number of recipients and the average UBII entitlement, variant HAStricter2 would be preferable, as it better achieves the aggregated expenditure value due to the higher simulated number of benefit recipients (N).

Next, we take a look at various UBII components that cannot be considered in the simulation. ***Table 5*** shows various measures of the distribution of single payments to housing costs (for example, renovation costs), contributions to health insurance and sanctions, i.e., reductions in benefits if obligations to look for work or to accept a job are not met. The table shows that sanctions and single payments for housing costs are negligible, since they affect only a very few numbers of benefit recipients as the values up to the 0.9 quantile are zero and if they are observed, values are rather small. Health insurance contributions are paid for the majority of UBII recipients. They are only not paid if recipients are insured outside the UBII system, usually through dependent employment subject to social insurance contributions.[2] In this context, it should be noted that these payments are not paid to the benefit recipient, but are transferred directly to the health insurance company. Therefore, neglecting these benefits in the simulations could affect the simulation of fiscal effects if a reform alters the number of benefit recipients, but not the simulation of effects on benefit recipients' personal income. Approximately 31 percent of all observed recipients in our data receive payments for special needs. The average payments, however, are low with a mean value of 18 Euro and a 0.9 quantile value of 60 Euro. As the most important benefit among these special payments is covered by the UBII simulation, the additional benefit for single parents, the neglect of other specific UBII components should not introduce a significant bias to the estimates of fiscal aggregates. Overall, it can be assumed that the UBII simulation covers the most important benefits and thus also produces meaningful simulation results with regard to fiscal variables.

Table 5. Distribution of UBII single payments, payments for special needs, contributions to health insurance and sanctions (Euro per month).

	Single payments housing costs	Payments for special needs	Contributions to health insurance	Sanctions
Mean	5	18	177	8
Std. deviation	90	43	90	65
0.1 quantile	0	0	0	0
0.5 quantile	0	0	117	0
0.9 quantile	0	60	250	0
0.99 quantile	0	163	470	240

Source: SIG version 0720, own calculations.

Finally, ***Table 6*** shows the variation of the simulated UBII entitlement in comparison to the recorded entitlement across different subgroups. There are only few differences between males and females; all simulation variants match the mean value of the recorded UBII entitlements to approximately the same extent (96 to 101 percent). Significantly more differences become visible in the results across household types. For singles and couples without children living in the household, the average simulated benefit entitlement almost perfectly matches the recorded average entitlement (99 to 100 percent). It can be assumed that households without children have a less complex household and income structure. This is also indicated by the low standard deviation in relation to the mean for singles, and therefore their entitlements can be simulated more precisely. If children live in the household, the simulation becomes less accurate, as the comparison between singles and single parents as well as couples with and without children shows, especially for the variants HAStricter1 and HAStricter2. With regard to age groups, the worst fit at the mean is achieved for the youngest age group up to 35 years in all simulation variants (91 to 94 percent). Older age correlates with the household types of single people and couples without children, which partly explains these differences. Interestingly, for UBII recipients who have income from self-employment in their household, we find a higher simulated entitlement than the recorded entitlement in all variants.

Overall, the deviations for the two variants GETTSIM and NoRentLimit are smaller for most groups than for HAStricter1 and HAStricter2. Considering that the beta error was minimized for variants HAStricter1 and HAStrichter2, this implies that inaccuracies increase when more households are included that are in the grey area between different available benefits (UBII and HA).

5.3. Distribution and determinants of individual deviations between the simulated and recorded UBII entitlements

In the previous sections, the validity of the simulation results was examined with regard to aggregate statistics. This is particularly relevant when estimating the impact of policy changes on aggregate variables such as distribution measures or fiscal outcomes. However, simulation results can also be used for analyses at the individual level. One example would be the analysis of the effects of the tax and transfer system on observed individual labour market transitions (***Bartels and Pestel, 2016***; ***Fossen, 2009***). Therefore, this section examines individual errors in more detail. We compare the deviation of the simulated individual monthly UBII entitlement from the recorded entitlement in the administrative data. The investigation is only carried out for variant NoRentLimit, which showed

Table 6. Recorded and simulated UBII entitlements by subgroup (mean values (standard deviation) in Euro per month, simulated mean value (standard deviation) relative to recorded mean value (standard deviation) in percent).

	Recorded UBII-entitlement	GETTSIM		NoRentLimit		HAStricter1		HAStricter2	
Females	912	907	99%	917	101%	890	98%	883	97%
	(512)	(431)	(84%)	(440)	(86%)	(442)	(86%)	(446	(87%)
Males	871	841	97%	850	98%	841	97%	836	96%
	(487)	(400)	(82%)	(412)	(85%)	(410)	(84%)	(412)	(85%)
Singles	655	648	99%	657	100%	654	100%	650	99%
	(231)	(189)	(82%)	(199)	(86%)	(202)	(87%)	(206)	(89%)
Single Parents	885	905	102%	913	103%	851	96%	844	95%
	(399)	(292)	(73%)	(301)	(75%)	(337)	(84%)	(343)	(86%)
Couple w/o children	880	873	99%	879	100%	875	99%	873	99%
	(389)	(354)	(91%)	(358)	(92%)	(361)	(93%)	(363)	(93%)
Couple w/ children	1,262	1,258	100%	1,268	100%	1,170	93%	1,158	92%
	(617)	(420)	(68%)	(439)	(71%)	(472)	(77%)	(480)	(78%)
25-<35 years old	905	843	93%	852	94%	827	91%	821	91%
	(510)	(374)	(73%)	(386)	(76%)	(386)	(76%)	(390)	(76%)
35-<45 years old	999	995	100%	1004	101%	973	97%	966	97%
	(572)	(471	(82%)	(481)	(84%)	(481)	(84%)	(485)	(85%)
45-<55 years old	869	880	101%	891	102%	881	101%	876	101%
	(475)	(436)	(92%)	(446)	(94%)	(447)	(94%)	(449)	(95%)
>54 years old	755	759	100%	768	102%	761	101%	756	100%
	(357)	(330)	(92%)	(338)	(95%)	(341)	(96%)	(344)	(96%)
With income from self-employment	830	896	108%	905	109%	879	106%	873	105%
	(430)	(420)	(98%)	(423)	(98%)	(420)	(98%)	(424)	(98%)

Note: Grey cells represent the deviation from the group mean of the registered UBII claims, with increasing deviations for darker colours.
Source: SIG version 0720, GETTSIM v0.7.0, own calculations.

the smallest deviation from the mean of the entitlement distribution in the administrative data, and variant HAStricter2, which showed the smallest deviation from the total number of UBII recipients (see ***Table 4***).[3]

Figure 3 shows the distribution of the calculated differences (recorded UBII minus simulated UBII). Most observations show only very small individual deviations of less than 20 euros. The median of the difference amounts to 1 Euro for NoRentLimit and 1.33 Euro for HAStricter2. 50 percent of all observations show a deviation between 2.34 Euro (0.25 quantile) and 29 Euro (0.75 quantile, variant NoRentLimit). There are only minor differences in the distribution of deviations between the two simulation variants. However, larger, mainly positive deviations can also be seen in ***Figure 3***. Positive deviations mean that simulated entitlements are below recorded entitlements, which corresponds to UBII components that cannot be considered in the simulation and was already discussed for the aggregated distribution measures. The lack of a bunching of certain values indicates no systematic

3. 3 Since there may be outliers in the administrative data, the recorded UBII claims are trimmed at the 1st and 99th percentiles. Sanctions could be a possible reason for very low benefit payments in a given month. Additional payments, for example, due to increased temporary heating costs, can lead to exceptionally high payments in a given month.

deviations due to specific, identifiable reasons. To uncover systematic differences related to specific characteristics of the benefit recipient, we next regress the individual deviations on a variety of observable characteristics. The results are presented in ***Table 7***.

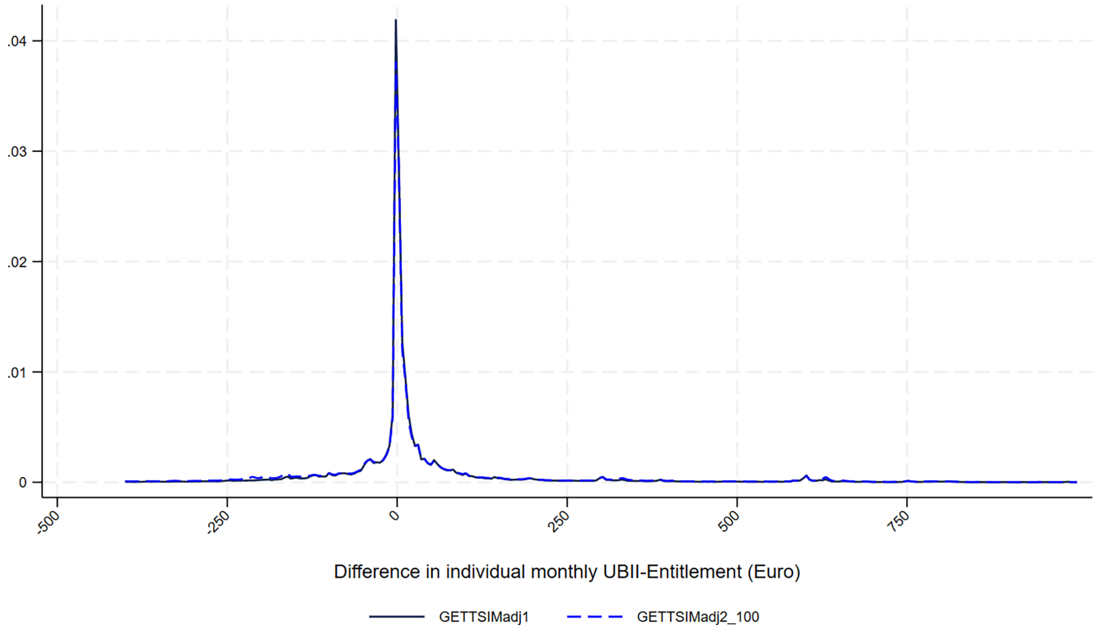

Figure 3 Distribution of the individual deviation of the simulated monthly UBII entitlement from the recorded UBII entitlement (Euro).

Source: SIG version 0720, GETTSIM v0.7.0, own calculations.

Table 7. Regression results.

	Dependent variable: Deviation of monthly recorded UBII-entitlement (in euros) from simulated entitlement according to simulation variant...					
Explanatory variables	**NoRentLimit**			**HAStricter2**		
	Coefficient	Stat. Sig.	N	Coefficient	Stat. Sig.	N
Age (years)	-10.45	***	1169	-13.44	***	1269
Age_squared (years)	0.11	***	1169	0.14	***	1269
Female (ref.: male)	-1.08	***	548	-3.08	***	607
Marital status (ref.: single)						
Married, living separately	7.8	***	55	12.98	***	60
Married, living together	-12.04	***	354	-12.65	***	403
Divorced	11.63	***	120	16.15	***	128
Widowed	-6.91	***	13	-5.44	***	15
Unknown	-38.65	*	0	-61.85	*	0
Employment status (ref.: unemployed)						
Regular employed	-16.23	***	134	-29.71	***	168
Vocational training	-15.65	***	9	-31.49	***	11
Marginal employment	-17.55	***	135	-28.17	***	141
Else	57.94	***	5	51.22	***	5
Country/region of nationality (ref.: Germany)						

	Dependent variable: Deviation of monthly recorded UBII-entitlement (in euros) from simulated entitlement according to simulation variant...					
Explanatory variables	**NoRentLimit**			**HAStricter2**		
EU	-10.54	***	84	-7.36	***	95
Turkey	-14.04	***	58	-9.56	***	65
Balkan countries	1.33		23	5.78	***	26
Eastern Europe	4.35	***	16	6.75	***	17
Africa	26.71	***	26	38.21	***	29
America	-5.81	**	4	9.89	**	4
Asia	32.29	***	151	61.24	***	168
Else/Unknown	12.36	***	4	98.16	***	5
Status when entering Germany (ref.: No status, no information, missing)						
(ethnic German) Resettler (*Spätaussiedler*)	-9.52	***	3	-14.36	***	3
Person entitled to asylum	3.63		4	14.07	***	4
Asylum seeker	26.43	***	4	26.11	***	4
Quota system refugee (Kontigentflüchtling)	-7.05	**	2	-16.52	***	2
Residence status (ref.: German, EU-resident, missing)						
Permit of residence	6.13	***	176	11.72	***	198
Temporary permission to stay	59.14	***	6	115.76	***	7
Settlement permit	-19.42	***	82	-29.78	***	91
Visa	11.63	***	3	53.89	***	3
Other permission	-11.37	***	7	-15.17	***	8
Asylum application not yet submitted	67.87	***	2	78.78	***	2
Living space (square meters)	-0.23	***	1169	-0.33	***	1269
Number of people living in the household	25.71	***	1169	39.71	***	1269
Family type (ref.: Single)						
Single parent	-5.51	***	153	-8.61	***	177
Couple w/o children	2.06	***	133	-4.99	***	136
Couple w/ children	59.95	***	240	49.16	***	293
Additional needs due to disability	121.96	***	3	116.96	***	3
Severe disability (ref.: No)						
Yes	3	***	53	2.86	***	56
No information/missing	29.81	***	11	42.43	***	12
Eastern Germany (ref.: Western Germany)	3.76	***	328	9.36	***	355
Year 2018 (ref.: 2017)	-2.52	***	570	-1.22	***	619

Explanatory variables	Dependent variable: Deviation of monthly recorded UBII-entitlement (in euros) from simulated entitlement according to simulation variant... NoRentLimit		HAStricter2	
Intercept	215.14	***	278.05	***
N (in thousands)	1,169		1,269	
Adjusted R-squared	0.13		0.11	
Outcome (mean, euros)	31		54	

Notes: Asterisks */**/*** indicate statistical significance at the 10/5/1 per cent level, based on heteroscedasticity robust standard errors.
Source: SIG version 0720, GETTSIM v0.7.0, own calculations.

For most explanatory variables the deviation under control of other characteristics expressed in the coefficient is small with less than 20 Euros. Especially for the distinction between males and females (1.08), couples without children compared to singles (2.06), severe disabled persons compared to not disabled persons (3), recipients from eastern Germany compared to western Germany (3.76) and simulations for the year 2018 compared to the year 2017 (-2.52) almost no relevant differences can be detected.

The coefficients for the age variables show that the deviations between recorded and simulation entitlements decrease with increasing age. Differences in marital status also show only minor deviations, with the exception of the status “unknown” (missing), where the deviation compared to a single person amounts to 39 Euro. However, there is only a negligible number of observations with missing values for this variable. More interesting are the results for the variable measuring different employment statuses. It can be argued that the complexity of recipients' personal circumstances considered in a tax benefit simulation increases for employed recipients compared to unemployed recipients, for example due to work related tax deductions that could often not be measured. The results in ***Table 7*** support these assumption with, albeit small, deviations for all forms of employment compared to the unemployed. Again, the highest coefficient is estimated for the absorbing state "else" (57.94).

Regarding the country or region of nationality, higher coefficients are observed for countries from Asia (32.29) or Africa (26.71), meaning a higher deviation compared to their German counterparts. This is particularly relevant since these categories also represent relatively large groups of benefit recipients (151 and 26 thousand, NoRentLimit). These are often people who came to Germany as asylum seekers from crisis countries. For example, 68 percent of all people from the Asian category come from Iraq and Syria. For these persons, the benefit calculation could be more complex, leading to a less precise simulation with given data. This interpretation is supported by the findings for the variables measuring the status when entering Germany and the residence status. Statistically significant and higher coefficients compared to the reference categories are found for asylum seekers, persons with a temporary permission to stay, a settlement permit and for those who have not yet submitted their asylum application. Unfortunately, the external validity of these two characteristics is not very high, as the low number of observations demonstrates. The reference category may include not only individuals who have not migrated to Germany but also immigrants without information, so the effects would likely be even larger with a more precise measurement. The further results show that household size and composition also play a role. The simulation tends to be less accurate for larger households and households with children. A large effect is found for households who receive benefits for additional needs due to disability (121.96), however, this affects only a very small group of 3 thousand observations.

6. Conclusion

The simulation of social benefit entitlements with tax-benefit microsimulation models offers the opportunity to investigate many research questions. For example, the effects of policy changes on the income of those affected and on public budgets could be analysed. The analysis of benefit non-take-up also requires the simulation of benefit entitlements based on suitable data to determine the eligible population. However, securing the minimum income with a means-tested benefit is more complex than applying pure calculation logic, and the benefit simulations are usually inaccurate at various points, due to, for example, discretionary decisions. Against this background, we examine the results of an open-source tax-benefit microsimulation model (GETTSIM) for the simulation of a means-tested social benefit intended to ensure the minimum income in Germany (UBII). Our data allows us to apply the simulation to administrative data of UBII recipients collected during the application process and to compare the simulation outcomes with the recorded UBII entitlements. Using these accurate data minimizes simulation errors due to time period issues or typical measurement errors of survey data, such as over- or underreporting of income.

The results show that UBII entitlements are in most cases correctly simulated. In an adapted version of GETTSIM we used, only for 3 to 4 percent of all observations failed to simulate a UBII claim (beta error). The simulation also allowed a precise distinction between UBII and existing similar benefits (housing and means-tested child benefit) for most observations. To obtain these results, two adjustments to the GETTSIM v0.7.0 were made: First, the limit used in the simulation for the accepted rent in UBII was suspended because we can measure the accepted rent in our data. This data specific adjustment cannot be generalized as this information is usually not available in other (survey) data. Second, we integrated the regulations to distinguish between UBII and housing allowance more precisely. The high beta error of 9 percent in the results achieved with GETTSIM v0.7.0 without this adjustment supports the implementation of the regulation, as is already done in newer versions of GETTSIM. We further find a high match between the distributions of simulated and recorded UBII entitlements. The simulated mean values underestimate the mean of recorded entitlements only to a limited extent which should not introduce a significant bias to the estimates of fiscal aggregates. As expected, the variance of simulated entitlements is below the observed variance, as heterogeneity in the application process could not be reflected in the simulation. This can be particularly distorting for the analysis of subgroups, where we find varying degrees of fit to the recorded entitlements. A closer look at individual deviations between recorded and simulated entitlements reveals significant deviations for migrants, especially from crisis countries, which was particularly relevant in 2017 and 2018. In our data, this is probably related to the strong influx of asylum seekers to Germany and into the transfer system since mid-2015. Our results also suggest that also in households with many family members, with children or employed persons in the household, the simulation at the individual level is less precise. In summary, we conclude that GETTSIM is a powerful and easy-to-implement tool for the simulation of UBII entitlements and the analysis of policy change on aggregated outcomes. At the individual level, accurate results are also obtained for the vast majority of households. However, the composition of the households is important, and larger errors can be expected for more complex household structures.

The results also provide some insights for the analysis of eligibility based on tax-benefit simulations in general. In social policy systems with overlapping benefits, even with very good data quality, misspecification of benefit entitlements cannot be avoided to a relevant extent, especially when the benefits pursue similar objectives and discretionary decisions occur at the administrative level. For the analysis of policy measures on the number of recipients and the costs of various transfers, this implies that simulation results become less accurate depending on the degree of complexity and overlap. Since the mean values of various large sociodemographic groups are relatively accurately determined in the simulation, calibrating the simulated recipient numbers can compensate for these inaccuracies. In our case, we even found that the inaccuracy in the mean values tended to increase in the variants that achieved better results in the number of correctly simulated entitlements, implying that for households in the grey area between different available benefits (in our case UBII versus HA and CB) simulation outcomes are less precise. The analysis at the individual level has shown that simulation quality decreases particularly for subgroups with more complex life circumstances, such as households with children. This applies in particular to comprehensive last-resort minimum income systems that provide benefits in the household context and take all types of household income into account. Temporary special circumstances can also lead to simulation results that do not reflect actual payments. One example taken from our findings are the higher simulation inaccuracies for individuals with citizenship from a crisis country in connection with a strong influx of asylum seekers to the German benefit system. In crisis years, consideration should be given to excluding certain particularly affected subgroups from the analysis or to choose other simulation years, if possible.

If a high data quality can be assumed, the imprecision in differentiating between different benefits implies for the analysis of benefit non-take-up that among the households typically reported as beta errors, a large proportion is actually eligible. If the beta-error households are not included in the denominator of the non-take-up rate in this case, this leads to an overestimation of the non-take-up rate. Conversely, if the data quality is poor, beta error households would be to a large extent due to benefit overreporting and the inclusion in the calculation of the non-take-up rate would lead to an underestimation of true non-take-up. The favourable approach must be decided on depending on the quality of the data and the complexity and overlap of benefits. One possible approach for the analysis of highly overlapping benefits would be to consider a combined (non-)take-up rate for these benefits in the sense that a household is only classified as non-take-up household if it is simulated as eligible for one of the benefits but does not claim any of them.

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Conflict of Interest

No competing interests reported.

Data access

The analyses are based on a 2% subsample of the Sample of Integrated Welfare Benefit Biographies (SIG), version 0720. The data are held by the Institute for Employment Research (IAB). Address: Regensburger Str. 100, D-90478 Nuremberg. Website: https://iab.de/en/. Social security and survey data held at IAB are processed and stored at IAB in accordance with the German Social Code (Book III). The data contain sensitive information on individuals and firms and are therefore subject to the strict data privacy regulation of the German Social Code (Book I, Section 35, Paragraph 1). External researchers may be granted access to the data for replication purposes on the premises of IAB in Nuremberg, subject to the provisions of Section 282 (7) of the German Social Code - Book III (§282 Absatz 7 Sozialgesetzbuch – Drittes Buch) and subject to availability of the required infrastructure at the research data center of IAB. Charges may apply. Real identifiers (e.g., address information, names) cannot be provided in this case. If access cannot be granted, a Ombudsperson will initiate a case-by-case review. In cases where real identifiers are necessary for replication purposes, external researchers can apply for data access subject to the provisions of Section 75 of the German Social Code - Book X (§75 Sozialgesetzbuch – Zehntes Buch). The corresponding author will help researchers interested in replicating the results to fill in the necessary forms. Data access is conditional on authorization by the Federal Ministry of Labour and Social Affairs. Charges may apply. Further information on data access for replication purposes is provided on the website of IAB, see https://iab.de/en/facts-and-figures-2/data-access-for-replication-purposes/. In case of doubts about the results of the research, researchers can contact the Ombudsperson for Good Scientific Practice at IAB (ombudsperson@iab.de). The original data, a replication package, and additional materials are archived at IAB.

References

Bargain O, Immervoll H, Viitamäki H. 2012. No claim, no pain. Measuring the non-take-up of social assistance using register data. *The Journal of Economic Inequality* **10**: 375–395. DOI: https://doi.org/10.1007/s10888-010-9158-8

Bartels C, Pestel N. 2016. Short- and long-term participation tax rates and their impact on labor supply. *International Tax and Public Finance* **23**: 1126–1159. DOI: https://doi.org/10.1007/s10797-016-9400-9

Bruckmeier K, Riphahn RT, Wiemers J. 2021. Misreporting of program take-up in survey data and its consequences for measuring non-take-up: new evidence from linked administrative and survey data. *Empirical Economics* **61**: 1567–1616. DOI: https://doi.org/10.1007/s00181-020-01921-4

Doorley K, Kakoulidou T. 2024. The Trouble with Take-Up. *The B.E. Journal of Economic Analysis & Policy* **24**: 673–682. DOI: https://doi.org/10.1515/bejeap-2023-0170

Dummert S, Grunau P, Hohmeyer H. 2022. Sample of Integrated Welfare Benefit Biographies (SIG) 2007-2020. *Institute for Employment Research (IAB)*.

Fossen FM. 2009. Would a Flat-Rate Tax Stimulate Entrepreneurship in Germany? A Behavioural Microsimulation Analysis Allowing for Risk*. *Fiscal Studies* **30**: 179–218. DOI: https://doi.org/10.1111/j.1475-5890.2009.00093.x

Frick J, Groh-Samberg O. 2007. To claim or not to claim: estimating non-take-up of social assistance in Germany and the role of measurement error. *Deutsches Institut Für Wirtschaftsforschung (DIW)* **DIW Discussion Papers 734**. https://hdl.handle.net/10419/27258

Goedemé T, Janssens J, Derboven J, Gestel R, Lefevere E, Verbist G, Vergauwen J, Vandervelden M, Nisen L, Linchet S, Bolland M, Reynaert J-F, Thiry B, Novella M, Boucq E, Bosch K, Mechelen N, Corselis A. 2022. TAKE: Reducing poverty through improving the TAKE up of social policies. *Belgian Science Policy Office 2022*.

Harnisch M. 2019. [Non-Take-Up of Means-Tested Social Benefits in Germany]. *Deutsches Institut Für Wirtschaftsforschung (DIW)* **DIW Discussion Paper 1793**. DOI: https://doi.org/10.2139/ssrn.3352378

Hufkens T, Leventi C, Rastrigina O, Manios K, Mechelen N, Verbist G, Sutherland H, Goedemé T. 2016. [HHoT: a new flexible Hypothetical Household Tool for tax-benefit simulations in EUROMOD (Deliverable 22.2)]. Leuven, FP7 InGRID project.

Jara HX, Oliva N. 2018. [Top income adjustments and tax reforms in Ecuador]. *World Institute for Development Economic Research (WIDER)* **Working Paper 2018/165**.

Richiardi M, Collado D. 2021. UKMOD – A new tax-benefit model for the four nations of the UK. *International Journal of Microsimulation* **14**: 92–101. DOI: https://doi.org/10.34196/IJM.00231

Siebertova Z, Svarda N, Valachyova J. 2016. Improving the Validity of Microsimulation Results: Lessons from Slovakia. *International Journal of Microsimulation* **9**: 77–105. DOI: https://doi.org/10.34196/ijm.00136

Sutherland H, Decoster A, Matsaganis M, Tsakloglou P. 2009. [AIM-AP: Accurate income measurement for the assessment of public policies. Final Report, STREP Project No. 028412, ISER]. University of Essex.

Sutherland H, Figari F. 2009 EUROMOD: the European Union tax-benefit microsimulation model. *International Journal of Microsimulation* **6**: 4–26. DOI: https://doi.org/10.34196/ijm.00075

Tasseva IV. 2016. Evaluating the performance of means-tested benefits in Bulgaria. *Journal of Comparative Economics* **44**: 919–935. DOI: https://doi.org/10.1016/j.jce.2016.02.003

Appendix A

Table A1. Composition of the simulation sample and the excluded values where no simulation was possible (last sample selection step).

	Simulation Sample	No valid simulation possible	Difference	
	years (mean)		absolute	p-value*
Age	42.6	43.8	-1.14	0.00
	shares			
Female	0.49	0.40	0.09	0.00
Single	0.47	0.01	0.47	0.00
Single Parent	0.15	0.42	-0.27	0.00
Couple w/o children	0.10	0.02	0.09	0.00
Couple w/ children	0.27	0.52	-0.24	0.00
Eastern Germany	0.28	0.25	0.03	0.01
No school leaving certificate	0.21	0.18	0.03	0.00
No German citizenship	0.34	0.34	0.00	0.04
Observations	1,427,470	224,204		

Source: SIG version 0720, own calculations.
*p-value of a t test on the equality of means.