Methods and Assumptions of the CPS ASEC Tax Model[*]

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Abstract

The Census Bureau's CPS ASEC Tax Model imputes federal and state taxes and credits for the Current Population Survey Annual Social and Economic Supplement (CPS ASEC) on an annual basis. The imputed information is also reflected in the Census Bureau's Income and Poverty reports examining post-tax income and the Supplemental Poverty Measure. The Census Bureau created the CPS ASEC Tax Model in the early 1980s, and the model undertook a major methodological update in 2004. This paper provides users a comprehensive documentation of the CPS ASEC Tax Model. It details the methodology, assumptions and data underlying the model. Specifically, the paper describes in detail the formation of tax units, construction of income, statistical match to IRS microdata, iterative calculations of federal and state taxes and credits, requirements for filing, and a description of the output variables. This paper also discusses the limitations of the CPS ASEC Tax Model and presents aggregate statistics for comparisons with tabulations from the Internal Revenue Service.

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[*]This paper is released to inform interested parties of ongoing research and to encourage discussion of work in progress. All errors are those of the authors. Any views expressed, including those related to statistical, methodological, technical, or operational issues, are solely those of the author and do not necessarily reflect the official positions or policies of the U.S. Census Bureau. The Census Bureau has reviewed this data product to ensure appropriate access, use, and disclosure avoidance protection of the confidential source data used to produce this product (Data Management System (DMS) number: P-7503840, Disclosure Review Board (DRB) approval number: CBDRB-FY22-SEHSD003-050.

Introduction

The Census Bureau imputes federal, state, and payroll tax liabilities and several tax credits for the Current Population Survey Annual Social and Economic Supplement (CPS ASEC), because the CPS ASEC does not collect information from respondents about taxes paid or tax credits received.[1] The imputed information is reflected in many Census Bureau statistics and publications, including post-tax income in the report *Income in the United States: 2021* and the Supplemental Poverty Measure (SPM) in the report *Poverty in the United States: 2021*. The CPS ASEC Tax Model is the Census Bureau's internal model that imputes the tax variables released in the both the internal and public-use CPS ASEC and SPM.

There are several other popular tax models, such as National Bureau of Economic Research's (NBER) TAXSIM (Feenberg and Coutts 1993) and Jon Bakija's Income Tax Calculator (Bakija 2019). Census has produced summaries and evaluations of the Census CPS ASEC Tax Model over the years (O'Hara 2004, 2006, Webster 2011), but, to date, Census Bureau had not released official documentation for CPS ASEC Tax Model.

The motivation for producing and releasing this official documentation is to inform users of the CPS ASEC data about how existing tax variables are constructed, thereby benefiting and improving research using those variables. CPS ASEC data is often linked to administrative records for studies on income transfer programs such as the Earned Income Tax Credit (EITC) (Jones and Ziliak 2020, Jones 2014) and on top income distribution (Burkhauser et al 2012). Some studies construct their own tax units from the CPS ASEC (Goldin and Michelmore 2020). Like the CPS ASEC Tax Model, the Congressional Budget Office uses a statistical match of IRS Statistics of Income data to CPS ASEC for its annual publication on the distribution of after-tax income (CBO 2021).

This paper documents the assumptions and methodology of the tax variables imputed under the CPS ASEC Tax Model, discusses the limitations of the model, and provides a review the soundness of the outputs.

Background

Accurate individual-level and household-level measures of tax liabilities and credits are important to various research topics. However, outside of the Survey of Income and Program Participation (SIPP),

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[1] For the technical documentation of the March 2022 Annual Social and Economic Supplement, see < https://www2.census.gov/programs-surveys/cps/techdocs/cpsmar22.pdf>.

household surveys conducted by the Census Bureau do not explicitly ask for information on taxes.[2] Therefore, information on tax liabilities and credits are imputed for the CPS ASEC.

The Census Bureau first used an internal tax model to produce after-tax income estimates for the 1975 and 1981 March CPS microdata files (Nelson and Feldman 1983). More information on the original tax model can be found in Appendix A. Since its inception in the early 1980s until 2004, the methodology for the original tax model remained the same except for the annual updates to account for changes in marginal tax rates.

In 2004, the Census Bureau introduced a newer tax model to produce tax estimates by more closely following the Internal Revenue Service (IRS) 1040 tax form and rules (O'Hara 2004). The updated model was first used for the March 2004 CPS ASEC and has been continuously updated to reflect annual change in federal and state tax codes.

The 2004 update allowed the CPS ASEC Tax Model to be updated to reflect annual changes in the tax code and introduced more tax items. Before the 2004 update, only the marginal tax rates were updated annually. Revised methodology was introduced in 2004 for the simulation of payroll taxes, federal individual income taxes, and state individual income taxes. The revised methodology for the 2004 CPS ASEC Tax Model can be summarized as follows.

i)   Within survey households, construct potential filing units and assign tax return status based on marital status and household relationships.

ii) Within tax filing units, calculate Adjusted Gross Income and other income items. At the person level, calculate payroll taxes for those with earned income.

iii) Use Statistics of Income (SOI) public use file (PUF) microdata produced by the IRS to supplement tax information not available from CPS ASEC.[3]

iv) Calculate taxes using an iterative process to ensure consistency between federal and state taxes and credits.

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[2] Starting in 2014, the SIPP has consistently asked questions on EITC receipt, whether households filed taxes, and their filing status. Tax questions have been asked occasionally in tax topical modules prior to the 2014 Panel. However, the survey does not ask detailed information on individual's tax obligations or credits received. Detailed tax questions were fielded in SIPP 2008 Topical Modules List Wave 5 and Wave 8. For more information, see <https://www2.census.gov/programs-surveys/sipp/questionnaires/2008/sipp-2008-panel-wave-05-topical-module-questionnaire.pdf> and < https://www2.census.gov/programs-surveys/sipp/questionnaires/2008/sipp-2008-panel-wave-08-topical-module-questionnaire.pdf>
[3] The SOI PUF microdata is created from a sample of completed 1040 tax forms.

v) Define a set of filing requirements to determine which units will be classified as tax filers vs non-filers

The CPS ASEC Tax Model has been improved since the 2004 update, but the underlying methodology and procedures remain the same. Over time, more items became available from CPS ASEC and the IRS SOI; therefore, more CPS ASEC variables could be included in tax calculation, and the matched variables improved as more variables becomes available in both the CPS ASEC and the SOI published sample data set of tax records. More sophisticated incorporation of tax filer characteristics and different tax laws were introduced to the model over time. The model identifies military, veteran, student, self-employed, state and local government-employed, or federal government-employed filers and constructs the appropriate credits and deductions. Availability of more variables allows the imputation of more granular state-level credits and deductions and more detailed itemized deductions.

CPS ASEC Tax Model

The Census CPS ASEC Tax Model is updated annually to incorporate changes to federal and state tax laws. These updates can be summarized into two types: parameter changes and programming changes. Parameter changes refer to updates in recurrent parameters such as amounts, thresholds, limits, and cutoffs, which are used to determine eligibility or to calculate taxes and credits. Examples include federal standard deduction amounts, income limits for Earned Income Tax Credits, credits per qualifying child for Child Tax Credit, and so on. Programming changes pertain to substantial changes to the actual tax code that requires updates to the programming code. Examples of programming changes include expansions to the federal Child Tax Credit, removal of personal exemptions from the Tax Cuts and Jobs Act (TCJA) of 2017, and the introduction of Economic Impact Payments and the unemployment benefits tax exclusion from the American Rescue Plan Act of 2021.

The current CPS ASEC Tax Model produces a Census internal and a public-use version of tax outputs. The main difference between the internal CPS ASEC and the public-use CPS ASEC is that the income components in the internal files are topcoded at higher values (Larrimore et al. 2008). The internal CPS ASEC Tax Model use inputs from the internal CPS ASEC data and the public-use CPS ASEC Tax Model uses inputs from the public-use CPS ASEC data. See Appendix B for more detail on the public-use CPS ASEC Tax Model.

Tax Units

In order to estimate taxes and credits, the CPS ASEC data first must be transformed from the person- and household-level survey data into tax units. A tax unit is a group of individuals who files a single tax return together, and it is not necessarily the same as a household.[4] The process for forming tax units begins by identifying three mutually exclusive subsets within the person-level file: (1) all married people; (2) all dependents; and (3) the remaining observations, hereafter referred to as "others". The first subset of all married people is defined as any record with a non-zero value for the spouse pointer variable (A_SPOUSE).[5] The second subset of all dependents is initially defined as any record not in the first subset with a positive value in the parent pointer variable (PEPAR1 and PEPAR2), meaning the individual was unmarried and lived in a household with at least one of their parents.[6] The remaining persons – with no values in spouse pointer or parent pointer – form the third subset of "others".

The second step involves making the following adjustments to those initial assignments. The subsets are modified to follow certain IRS definitions. The second subset is restricted to include only qualifying children or dependents as the IRS defines them – children aged 18 years or under, children under 24 and enrolled in school, or adult children with a disability.[7] The model assumes that the dependent subset satisfy the residency requirements of the IRS dependent definition.[8] The model does not identify qualifying relatives who are not a child, adopted child, stepchild, or foster child due to limitations in the ability to differentiate a non-child dependent from a separate tax filer. The tax model also does not model elderly dependents who are not disabled.[9] People in the second subset who don't fall under IRS dependent definition (for example, working adults with parents in the household) are moved to the "others" subset. In the last adjustment, anyone under age 15 in the "others" subset (with no parent pointer) are reassigned to the children subset. The tax model only constructs single dependents and does not assign married filers as dependents. The heads of the tax filing units will come from those in the married subset (1) and the "others" subset (3) and are identified after the linkage of dependents.

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[4] Because of the random sample nature of the survey, the CPS ASEC Tax Model cannot include individual that reside outside of the households (such as dependents) in the tax unit construction, meaning tax units constructed for purposes of the tax model are necessarily subsets of survey household units.

[5] A_SPOUSE points to the spouse's line number. Zero indicates none or children.

[6] Since all inputs to the tax model are based on responses to the household survey, only children and dependents in the same household are included.

[7] Age in the CPS ASEC is as of the survey date (February to April). Age used by the IRS is as of the end of the calendar year.

[8] To be claimed as a dependent, a person must be a U.S. citizen, U.S. resident alien, U.S. national, or a resident of Canada or Mexico, unless an adopted child lives with the taxpayer as a member of the household all year and satisfies all other dependency tests. To be claimed as a dependent, the child must have lived with the taxpayer for more than half of the year.

[9] An elderly person with passive income may be a single filer or a dependent.

Third, qualified dependents are linked to tax units. The dependent subset is attached to the tax unit of their parent or parents using the parent pointer variable. Those under 15 without a parent pointer are assigned as dependents to the main tax filing unit within their survey household. The number of qualifying children and qualifying dependents under different definitions for various federal and state deduction and credits, including economic impact payments, are calculated and assigned for each tax unit. Qualified dependents may file their own taxes if they have sufficient earnings and they follow different tax schedules than regular filers. These dependents remain attached to the parent tax units under the same tax unit ID but are given their own separate tax observations.

Fourth, the model assigns filing status for each tax unit. If the tax unit contains two spouses, then the filing status of the unit is set to Married, Filing Jointly, and the spouses' incomes are summed for the tax unit.[10] The main filer is determined by the family relationship variable where the reference person is the main filer, and the spouse is attached to the main filer. The CPS ASEC Tax Model assumes that all married couples file jointly, so it does not model the Married, Filing Separately filing status. If the tax unit contains a single person that has dependents, then the filing status is set to Head of Household. If the tax unit contains only a single person, then the filing status is set to Single. Due to challenges with identifying married separate filers and qualifying widow(er)s, the filing status in the CPS ASEC Tax Model only consists of Single, Married Filing Jointly, and Head of Household.[11]

Income

Person-level earned income data are used to calculate federal payroll taxes or FICA taxes, which consist of Social Security and Medicare taxes. Wage and salary earnings, self-employment earnings, and farm self-employment earnings along with other employment indicators such as school enrollment, hours worked per week, age, industry and occupation are used to determine FICA taxes. Some workers such as clergy, teenagers working in a family business, and students working at universities are excluded from payroll taxes. Special calculations are performed for federal employees under the Civil Service Retirement System (CSRS), for which enrollment ended in 1986. CSRS status is randomly assigned, based on a percentage obtained annually from OPM, to federal workers in the expected age group.[12]

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[10] Separate income items are kept for calculation of tax credits that require individual spouse information.
[11] Qualifying widow(er) filing status is only available for two years following the death of the spouse. The CPS ASEC has indicator for "married, spouse absent"; however, as the model assumes people choose filing status to minimize their taxes, it's almost always more advantageous for married filers to file jointly.
[12] The variable (FED_RET) associated with federal employees under the Civil Service Retirement System was removed in the 2022 CPS ASEC due to the decreasing size of the group.

Social Security and Medicare taxes for individuals with positive self-employment earnings are calculated separately.

Income items relevant to constructing federal adjusted gross income (AGI) and itemized deductions are pulled from the CPS ASEC for each person. Federal AGI is computed as the sum of the following income variables for the filer (and spouse, if married) as reported by or imputed to ASEC respondents : wages and salaries, interest and dividend incomes, alimony income, business self-employment income, capital gains, IRA income, pension income, rent income, farm self-employment income, taxable unemployment compensations, and taxable Social Security benefits, and then subtracted by one-half of self-employment taxes, self-employed health insurance, self-employed health savings, and IRA contributions.[13] Several components such as self-employment insurance, self-employed health savings, and IRA contributions are imputed from IRS microdata. Taxable portion of Social Security benefits, business self-employment, farm self-employment income, and rent income are calculated based on their respective worksheets and Form 1040 schedules.

A list of CPS ASEC income items and their construction into tax variables are presented in Table 1.

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[13] Some AGI and itemized deduction components are imputed from the IRS Statistics of Income microdata. Details are discussed in the Statistical Match section.

Table 1. Definition of CPS ASEC Tax Model income items (2019-2022 CPS ASEC)

	CPS ASEC item	Definition
Taxable Income	WSAL_VAL	Wage and salary earnings
	SEMP_VAL	Business self-employment earnings
	FRSE_VAL	Farm self-employment earnings
	INT_VAL	Interest Income
	DIV_VAL	Dividend Received
	OI_VAL & OI_OFF = 20	Alimony Received
	RNT_VAL	Rent Income
	UC_VAL	Unemployment Benefits
Social Security and VA benefits	SS_VAL	Social Security Income
	VET_VAL	Veteran's Administration Income
Schedule E Income	OI_VAL & OI_OFF = 7	Rents or Royalties Income
	OI_VAL & OI_OFF = 8	Estate or Trusts Income
Itemized Deduction	MOOP	Medical Out of Pocket Expenditures
	CAP_VAL	Capital Gains Value
Retirement Pension (Apply same distribution for secondary sources: PEN_VAL2 and PEN_SC2)	PEN_VAL1 & PEN_SC1 = 3	Federal Government Pension
	PEN_VAL1 & PEN_SC1 = {4,5}	State and Local Government Pension
	PEN_VAL1 & PEN_SC1 = 6	US Military Pension
	PEN_VAL1 & PEN_SC1 = 7	Social Security (US Railroad Retirement)
	ANN_VAL & ANN_YN = 1	Annuities Retirement Income
	PEN_VAL1 & PEN_SC1 = {1,2,3,4,5,6,8} + ANN_VAL & ANN_YN = 1	Total Retirement Pension
Survivor Income (Apply same distribution for secondary sources: SUR_VAL2 and SUR_SC2)	SUR_VAL1 & SUR_SC1 = 2	Federal Government
	SUR_VAL1 & SUR_SC1 = 3	US Military
	SUR_VAL1 & SUR_SC1 = 4	State and Local Government
	SUR_VAL1 & SUR_SC1 = 5	Social Security (US Railroad)
	SUR_VAL1 & SUR_SC1 = 8	Estate and Trust
	SUR_VAL1 &	Total Taxable Survivor Income

	SUR_SC1 = {1,2,3,4,9,10}	
Disability Income (Apply same distribution for secondary sources: DIS_VAL2 and DIS_SC2)	DIS_VAL1 & DIS_SC1 = 2	Taxable Disability Income
	DIS_VAL1 & DIS_SC1 = 3	Federal Government
	DIS_VAL1 & DIS_SC1 = 4	US Military
	DIS_VAL1 & DIS_SC1 = 5	State and Local Government
	DIS_VAL1 & DIS_SC1 = 6	Social Security (US Railroad)
	DIS_VAL1 & DIS_SC1 = {2,3,4,5,9,10}	Total Disability Income
Total Pension by Type	Federal Retirement + Survivor + Disability Income	Total Federal Government Pension
	Military Retirement + Survivor + Disability Income	Total Military Pension
	State and Local Retirement + Survivor + Disability Income	Total State and Local Government Pension
	Social Security Income + US Railroad Retirement + Survivor + Disability Income	Total Social Security Income

Statistical Match

The tax model requires additional data that has not been collected as a part of the CPS ASEC to complete the required tax forms. To fill in these gaps, the CPS ASEC Tax Model leverages information available in the Statistics of Income (SOI) public use file (PUF) microdata produced by the IRS with a statistical match. The SOI public use data is created from a sample of completed 1040 tax forms.

A statistical match to the SOI data is performed to model the line items from several 1040 supplemental forms for each tax unit for more accurate federal and state tax and credit calculations. CPS ASEC is matched to the SOI data based on variables that are captured in both datasets, including: modelled SOI income, number of dependents, filing status, the presence of childcare expenses, the presence of a mortgage, the presence of wages and salaries, the presence of self-employment earnings, the presence of business earnings (Schedule C), the presence of farm earnings (Schedule F), the presence of taxable Social Security benefits, the presence of interest and dividend earnings, and a high-income indicator.[14]

For a detailed list of variables taken from SOI PUF, refer to Table 2.

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[14] The modelled income variable is constructed from salaries and wages, interest received, alimony received, social security benefits in AGI, pensions and annuities received, total deductible IRA payments, dividends included in AGI, business earnings (Schedule C), rent earnings (Schedule E), and farm earnings (Schedule F) in both CPS ASEC and SOI.

Table 2. Matched SOI PUF variables

Self-employed health insurance deduction
Health Savings Account deduction
Total deductible individual retirement account (IRA) payments
Medical and dental expenses subject to reduction by AGI limit
State and local taxes
Real estate tax deductions
Total interest paid deduction
Contributions deduction, total
Miscellaneous deductions subject to AGI limitation, total
Net casualty or theft loss
Itemized deduction limitation

Note: SOI variable codes removed at the request of IRS Statistics of Income.

Some of the SOI variables previously imputed through the statistical match were added to the CPS ASEC questionnaire in 2010 (presence of a mortgage, childcare costs, and medical out of pocket expenses) and in 2014 (capital gains). After an SOI variable is added to the CPS ASEC survey, the survey response is used instead. The variable is then incorporated as a new item to be matched on to the SOI PUF.

To facilitate a balanced match, SOI sample is restricted to reflect the remaining ASEC sample, and variables in each file are modified to be more equivalent. The SOI sample is restricted to single filers, head of household filers, and married joint filers. SOI cases with individual losses exceeding $10,000 (or $20,000 for married joint filers) in business earnings (Schedule C), rent income (Schedule E), or farm earnings (Schedule F) are omitted from the donor pool to better align with the CPS.[15] Certain restrictions are imposed on the imputed values. The imputed IRA contributions are limited to each person's legal limits. For example, IRA contributions are set to zero if filers (and spouse) have zero earnings. IRA contributions are prorated between the two spouses based on their individual earnings for married joint filers. Contributions are capped by age thresholds. Self-employed health insurance deductions and health savings are restricted by self-employed income. AGI calculated from CPS ASEC income items is updated

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[15] The CPS variables for self-employed income (SEMP_VAL), self-employed farm income (FRSE_VAL), and supplemental income, which composes of rent income (RNT_VAL) and royalty income (OI_VAL if OI_OFF =7) were bottom-coded at negative $9,999 when the codes were written.

by subtracting the imputed self-employed health insurance, self-employed health savings, and IRA contributions.

If the filer is a dependent, the imputed childcare expense, self-employed health insurance deductions, health savings, IRA contributions, and itemized deductions are set to zero. A random draw is done within different AGI bins to set the imputed itemized deductions and components to zero. Itemized deductions are set to zero for 100% of filers with AGI less than $10,000, 95% of filers with AGI less than $15,000, 75% of filers with AGI less than $30,000, and 60% of filers with AGI less than $50,000. These distributions may be revised based on future IRS publications.

A key limitation to the statistical match is the lag between the availability of SOI PUF data and the current CPS ASEC data. For example, the 2020 CPS ASEC Tax Model uses the 2014 SOI PUF data. The introduction of SOI PUF matching began with the 2000 SOI to 2004 CPS ASEC (O'Hara 2006). Refer to Table 3 for the history of SOI PUF updates and the corresponding ASEC tax years for which they're used

Table 3. History of SOI PUF matches

CPS ASEC Tax Model Tax Year	Corresponding SOI PUF
Tax Year 2004	2000 SOI PUF
Tax Year 2005	2001 SOI PUF
Tax Year 2006	2003 SOI PUF
Tax Year 2010	2004 SOI PUF
Tax Year 2011	2007 SOI PUF
Tax Year 2017	2011 SOI PUF
Tax Year 2020	2014 SOI PUF

Federal and State Taxes

The CPS ASEC Tax Model assumes that tax filers will select the deduction that provide the lowest tax liabilities and those who file will claim their maximum eligible tax credits. These assumptions may be optimistic and may lead to higher credits and lower tax liabilities given the same AGI than other tax models.

Individual income tax calculations follow an iterative process. Federal itemized deductions require state and local taxes as inputs. State taxes and credits often require federal taxes and credits, such as AGI,

itemized deduction amounts, Earned Income Tax Credit, and Child and Dependent Care Credit, as inputs. The initial estimates of federal taxes and credits are computed using the imputed state and local taxes from the SOI PUF. The initial estimates of federal taxes and credits are then used in the calculation of state taxes and credits. After state taxes and credit are computed, a second and final estimate of federal taxes and credits are calculated using the newly modelled state tax values in federal itemized deductions.

Federal tax and credit rules are updated annually based the new 1040 forms and other IRS supplemental forms to accommodate changes to tax laws. The Census CPS Tax Model applies, as best it can and based on the information available, the federal tax code and tax codes for all fifty states and the District of Columbia. The federal tax portion of the model applies both the shorter version using standard deductions and the longer version with itemized deductions, then chooses which deduction yields the lowest tax liability for each tax unit. The number of tax credits captured in the model is limited by the amount of data available from the ASEC and/or imputed from the SOI PUF. At the federal level, the model captures the Earned Income Tax Credit, the Child and Dependent Care Credit, the Child Tax Credit, the Additional Child Tax Credit (and Credit for Other Dependents beginning in tax year 2018), and the credit for the elderly and disabled. Examples of some changes made to the 2020 calculator include the suspension of charitable contribution limit for itemized deductions, the exclusion of unemployment compensation in AGI, and the introduction of Economic Impact Payments.

In the first run of calculating federal taxes and credits, AGI is adjusted using the income items imputed from the IRS SOI file. The model identifies the applicable standard deduction for each filing unit, based filing status (single, married filing jointly, and head of household), whether the filer (and spouse) is over 65, and whether the filer (and spouse) is blind. The standard deduction is then calculated for all filers (regular and dependent). Itemized deductions are calculated for all filers, using imputed itemized deduction components and imputed state and local taxes. The larger of the federal standard deduction and federal itemized deductions is taken, and an indicator variable for type of deduction taken is assigned to the tax filing units. After determining whether each tax unit takes the standard or itemized deduction, qualified business income deduction is subsequently estimated for each unit. Standard/itemized deductions and business income deductions are subtracted from AGI to produce federal taxable income. Federal income tax is then calculated based on the federal taxable income using the relevant tax year's tax rules. Afterwards, capital gains taxes and Alternative Minimum Tax (AMT) are calculated and added to total federal taxes. Nonrefundable credits such as Credit for the Elderly or the Disabled, Child and

Dependent Care Credit (CDC_CRD), Child Tax Credit and Credit for Other Dependents (CTC_CRD)[16] are calculated using the available eligibility information. Estimated federal taxes are reduced by nonrefundable credits to a minimum of zero; the resulting variable is federal taxes before refundable credit (FEDTAX_BC). Refundable credits – Earned Income Tax Credit (EIT_CRED) and Additional Child Tax Credit (ACTC_CRD)[17] – are calculated and applied to the federal taxes before refundable credits. The resulting variable is federal taxes after refundable credits (FEDTAX_AC), which can be below zero. A negative value of federal taxes after refundable credits indicates a refund, and the CPS Tax Model assumes that an individual will file taxes if they qualify for refundable credits even if the person does not meet the tax filing threshold. These preliminary federal taxes and credits are then used in the state-level calculations.

In the second step, the federal taxes and credits estimated in the prior step are used to calculate state taxes and credits, which often rely on federal tax items such as AGI, itemized deductions, Earned Income Tax Credit, and Child and Dependent Care Credit.

Similar to federal updates, state tax parameters are updated annually based on the state income tax forms and supplement forms. All existing state parameters are reviewed every year. Unlike with federal tax forms and instructions which typically have clear and standardized summary of changes, it can be challenging to parse changes in state-level tax forms. For every state, the current year's forms and instructions are also compared to the previous year's forms and instructions line by line to ensure all changes are captured in the CPS ASEC Tax Model. Examples of some state-level changes for tax year 2020 are updating Arkansas's Personal Tax Credit and Low Income Tax Tables, doubling Connecticut's percent pension and annuity income allowable for deduction, introducing a new Social Security benefits exclusion in West Virginia, and implementing idiosyncratic conformity to the federal unemployment benefits exclusion.

Calculation of state-level taxes and credits utilizes the estimated federal taxes and credits. The typical process for each state begins with a state-specific definition of AGI or income. Then the state taxable income is estimated by applying state adjustments to income such as deductions, exclusions, and

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[16] Child Tax Credit was fully refundable in tax year 2021 (2022 CPS ASEC); therefore CTC_CRD only contained Credit for Other Dependents for the 2022 CPS ASEC. For more information on the modeling of the 2021 Child Tax Credit, see Bee, Hokayem, Lin (2022) < https://www.census.gov/content/dam/Census/library/working-papers/2022/demo/sehsd-wp2022-17.pdf>

[17] For tax year 2021 (2022 CPS ASEC), since Child Tax Credit was fully refundable, the entire value of Child Tax Credit is in ACTC_CRD for the 2022 CPS ASEC.

exemptions to AGI or income. State-level standard deductions and itemized deductions are both calculated. Filers take the type of deduction they are allowed to take under their state-specific tax rules given whether they itemized on their federal tax return. If a state does not require conformity to federal itemizing status, the CPS ASEC Tax Model assumes the unit takes the larger of the two deduction types. Some states only allow filers who itemize in federal taxes to itemize in their state taxes, some states require filers who itemize in federal taxes to also itemize in their state taxes, and some states allow itemizing regardless of the filer's federal itemizing status. State taxable income is computed after applying adjustments to state AGI.

The state tax liability is calculated from the state taxable income; the resulting liability represents state taxes before all credits. The state tax liability is reduced by state-level nonrefundable credits to a minimum of zero. The new liability is then reduced by state-level refundable credits, and the resulting value is state taxes after all credits, which can be below zero. A negative value of state taxes after all credits indicates a refund, and the CPS ASEC Tax Model assumes that an individual will file taxes if they have refunds even if the person does not meet the tax filing threshold. The new state taxes are then used for the second run of federal taxes and credits.

After state taxes and credit are computed, a second and final run of federal taxes and credits is done using the new state tax values in federal itemized deductions under the same process as previously described.

Filing Requirements

The CPS ASEC Tax Model defines a set of filing requirements. The tax model assumes a tax unit files a return if it meets at least one of the following requirements: (1) income above IRS filing threshold determined by age and filing status; (2) positive Earned Income Tax Credit (EITC); (3) positive self-employment income; (4) gross income less than $0; (5) self-employment income less than $0; (6) positive Additional Child Tax Credit; (7) positive self-employment income for either spouse; or (8) has total income above $2,000.[18] Tax units that do not satisfy any of these eight requirements are presumed to be nonfilers and do not receive any tax credits even if they qualify. The main filers of tax units that do not meet the requirements are typically low-income, without children, or elderly.

For the 2021 CPS ASEC Tax Model, additional requirements are imposed on receiving the Economic Impact Payments (EIP_CRD). Tax units that do not file according to the ASEC Tax Model do not receive

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[18] As some people file even when they are not required, a minimum income lower than the IRS requirements was introduced to match the count of filers (O'Hara 2004).

any EIP amount with four exceptions. Presumed nonfilers reporting (or are imputed to receive) any Social Security, Supplemental Security Income (SSI), or Veterans Affairs (VA) benefits in the CPS ASEC are assigned both EIP amounts. These groups represent actual nonfilers who were automatically issued payments by the IRS. Additionally, EIP is assigned to presumed nonfilers who are in households that reported receiving (or were imputed to receive) any EIP amount.[19] These additional payments could be considered roughly analogous to the nonfiling households without Social Security, SSI, or VA payments who had to use the IRS online nonfiler tool in order to receive payment. Additional details on the imputation and assumptions are explained in SEHSD Working Paper No. FY 2021-18 (Bee, Hoyakem, and Lin 2021).

For the 2022 CPS ASEC Tax Model, the same requirements are imposed on receiving the third Economic Impact Payment (EIP_CRD). Additionally, CTC became fully refundable for tax year 2021. Historically, the variable ACTC_CRD was the refundable portion of CTC. This definition did not change for the 2022 CPS ASEC. Since in 2021 the CTC was fully refundable, ACTC_CRD reflected the entire CTC amount. Historically, CTC_CRD was the sum of the non-refundable portion of CTC and the credit for other dependents, so in the 2022 CPS ASEC it contains only the credit for other dependents. Additional details on the imputation and assumptions are explained in SEHSD Working Paper No. FY 2022-17 (Bee, Hoyakem, and Lin 2022).

Outputs

The tax units are merged back to the individual main filers under the CPS ASEC person file. The previously-defined filing requirements are applied to the tax units, so the presumed nonfilers do not receive certain tax credits even if they qualify. The final output variables of the CPS ASEC Tax Model are listed below in Table 4.[20]

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[19] The stimulus response variable used is an edited survey variable which includes imputed values and is available on the internal ASEC file. The modeled stimulus variable (EIP_CRD) is available on the public-use file.

[20] FED_RET is removed in the 2022 CPS ASEC due to the phasing out federal employees under the Civil Service Retirement System (CSRS). In the 2021 CPS ASEC, an additional variable, EIP_CRD, was imputed for the first two rounds of the Economic Impact Payments. In the 2022 CPS ASEC, additional variables, ADV_CTC and CDC_CRD are introduced for the expansion of Child Tax Credit and Child and Dependent Care Credit. OLD_CTC, OLD_ACTC, OLDFEDTAX_BC, and OLDFEDTAX_AC are released as counterfactual variables a research extract. See < https://www.census.gov/data/datasets/2022/demo/income-poverty/child-tax-credit.html>

Table 4. 2021 CPS ASEC Tax Model outputs

ACTC_CRD	Additional child tax credit
CTC_CRD	Child tax credit and other dependent credit
AGI	Adjusted gross income
DEP_STAT	Person index (A_LINENO) of filer who claimed this dependent
EIP_CRD	Sum of Economic Impact Payment 1 (CARES Act) and Economic Impact Payment 2 (CRRSA Act)
EIT_CRED	Earned income tax credit
FED_RET	Federal retirement payroll deduction
FEDTAX_AC	Federal income tax liability, after all refundable credits and Economic Impact Payments 1 and 2. FEDTAX_AC = FEDTAX_BC - ACTC_CRD - EIT_CRED - EIP_CRD
FEDTAX_BC	Federal income tax liability, before refundable credits
FICA	Social security retirement payroll deduction
FILESTAT	Tax filer status
MARG_TAX	Marginal tax rate
STATETAX_A	State income tax liability, after all credits
STATETAX_B	State income tax liability, before credits
TAX_INC	Taxable income amount
TAX_ID	Tax unit ID number

Limitations

The CPS ASEC Tax Model has several limitations. The CPS ASEC collects information on many detailed income sources, as well as many demographic characteristics. However, there are numerous topics that the CPS ASEC does not include that are important components to the tax code, including but not limited to items such as business profits and losses, farm expenses, and capital losses. These omissions are partially overcome by using data imputed from the Statistics of Income (SOI) microdata file from the IRS.

Another shortcoming is the lack of citizenship data, which is not available from any independent source. Residency affects a tax units total tax liability through eligibility for certain tax credits. The model assumes all survey respondents are U.S. residents for eligibility purposes.

Additionally, whenever information is not available to determine the eligibility of a tax unit for certain other tax credits, these credits are assumed to be zero. Examples of credits lacking eligibility information include certain education expense credits, energy credits, employment credits, and numerous other federal and state credits. Also, some tax units with low nonzero wages may file taxes to get their wage tax

withholdings returned to them if they did not owe any taxes, but the CPS ASEC only collects data on gross income. The tax model does not account for these situations.

Shortcomings of the Census tax model at the state level are the lack of granular geographic information on incomes and expenses. Many state credits require within-state qualifying expenses or within-state earnings and jobs. The tax model does not account for these credits, which require geographically specific incomes and expenses. The tax model also does not capture credits that require expenses to limited qualifying agencies. Also, it does not track states with health insurance individual mandate penalty due to poor matching of gaps in health insurance (Mykyta and Berchick 2021). Some examples of state-level credits, exclusions, or deductions not captured by tax model are Arizona's Credit for Contributions to Certified School Tuition Organizations, District of Columbia's Keep Child Care Affordable Tax Credit, Hawaii's military reserve deduction, and Mississippi's qualifying Charitable Contribution Credits.

Constraints surrounding the formation of tax units affects all tax models, including the CPS ASEC Tax Model. The CPS ASEC Tax Model does not capture married filing separately and widow/widower filers. The model assumes that the children in the dependent subset satisfy the residency and relationship elements of the IRS dependent definition, because the CPS ASEC data lacks the information needed to properly test for those types of eligibility. The CPS ASEC Tax Model, unlike other tax models, presorts persons into tax units. Other tax models, such as TAXSIM and the Bakija Income Tax Calculator, leave the construction of tax units to the users. The CPS ASEC Tax Model is limited by information available from the CPS ASEC. The CPS ASEC Tax Model has difficulty capturing dependents outside survey households, elderly dependents, and dependents age 15 and over who are not directly related to the primary filers. Differences in tax unit construction can lead to differences in outputs across different tax models.[21] Difficulty in the correct assignment of dependents may lead to underestimation in the aggregate of tax credits which require qualifying dependents.

Output Comparison

Table 5 compares aggregate statistics from CPS ASEC Tax Model to the official statistics published by the IRS for the 2020 filing season. The 2020 CPS ASEC (measuring income for tax year 2019) is benchmarked to the 2020 filing season statistics (tax year 2019) published by the IRS as of December 31,

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[21] Wheaton and Stevens (2016) compared the Census Bureau's tax calculator to TAXSIM and the Bakija tax model and found consistency in tax estimates across the models, given the same comprehensive input.

2020. The low aggregates of refundable ACTC and EITC highlights the limitations of the CPS ASEC Tax Model.[22]

Table 5. 2020 CPS ASEC/ SOI ratios and aggregate amounts

	ASEC/SOI Ratio	2020 CPS ASEC Tax Model aggregate ($Bil)	IRS 2020 filing season aggregate ($Bil)
Adjusted Gross Income	105.0	11,900	11,330
		(140.9)	
Taxable Income	103.4	9,025	8,727
		(118.5)	
Itemized Amount	110.9	701	632
		(15.0)	
Federal Taxes	91.7	1,449	1,579
		(24.1)	
Earned Income Credit	62.2	39	62
		(0.8)	
Child Tax Credit and/or Credit for Other Dependents	102.6	88	85
		(1.6)	
Additional Child Tax Credit	72.2	25	34
		(0.5)	

Sources: Internal Revenue Service Statistics of Income (SOI) 2020 Filing Season Statistics by AGI as of December 31, 2020 (https://www.irs.gov/statistics/filing-season-statistics). Census Bureau 2020 Current Population Survey Annual Social and Economic Supplement (CPS ASEC).
Notes: The ratios represent CPS ASEC tax-modeled aggregates to its corresponding IRS SOI benchmark. The IRS SOI benchmark is 2019 tax year aggregates as of December 31, 2020. The values in parenthesis are the standard error of the aggregate modeled sums. Amounts are in billions.

Table 6 reports a simple regression of modeled AGI from the 2021 ASEC Tax Model and AGI from the linked Form 1040 records. This table illustrates the fit of this simple AGI model. The R-squared of modeled AGI and actual AGI is 0.477 after restricting to AGI under $200,000.[23]

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[22] Meyer et al. (2020) and Wheaton and Stevens (2016) both find that when using only CPS ASEC as the input data, other tax calculators also underestimate EITC and CTC – the tax credits that require correctly attached qualifying dependents and children.

[23] Both the internal and public-use CPS ASEC income variables are topcoded, so the AGI needs to be restricted when comparing to actual AGI from IRS.

Table 6. Regressing linked IRS Form 1040 tax year 2020 adjusted gross income (AGI) on CPS ASEC-modeled tax year 2020 AGI

	(1)	(2) restricted to AGI $1-$150k	(3) restricted to AGI $1-$200k
	Linear		
	ty2020	ty2020	ty2020
Constant	45,190***	16,060***	17,230***
	(6,314)	(267.4)	(266.5)
AGI/10k	7,144***	6,323***	6,445***
	(1,204)	(53.65)	(49.68)
R-squared	0.008	0.452	0.477
N	63,000	39,000	41,000

Sources: 2021 CPS ASEC individually linked to tax year 2020 IRS Form 1040 records.

Notes: The dependent variable is AGI from individually linked IRS Form 1040 records, from ty2020, linked to primary filers. The main independent variable is AGI as modeled in the CPS ASEC tax model, based on responses to the 2021 CPS ASEC regarding income received during the 2020 calendar year and household characteristics at the time of interview. Form 1040 records are linked via Protected Identification Key of the primary filer. Self-employment is reported to the CPS. AGI sample restrictions are applied to both the IRS amounts and the CPS ASEC-modeled amounts. Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.01$

Applications

Because the CPS ASEC Tax Model is updated and runs in parallel with CPS ASEC production, the tax model has the ability to impute new tax variables alongside new CPS ASEC survey questions in the same year that tax legislation is enacted.

For example, in response to the COVID-19 pandemic, Congress passed the Coronavirus Aid, Relief, and Economic Security Act (CARES Act) in March 2020 and the Coronavirus Response and Relief Supplemental Appropriations Act (CRRSA Act) in December 2020. The legislation created additional refundable tax credits for the 2020 tax year to provide households with additional resources in the form of stimulus payments. The advance payments of these credits were referred to as the First Economic Impact Payments (EIP 1) and Second Economic Impact Payments (EIP 2). Furthermore, the American Rescue Plan Act (ARPA) temporarily expanded the CTC credit in March 2021 for the 2021 tax year.

Bee, Hokayem, and Lin (2021) modelled the first two Economic Impact Payments using the 2021 CPS ASEC Tax Model and the new survey response on receipt of Economic Impact Payments.[24] In the following year, Bee, Hokayem, and Lin (2022) modelled the expanded Child Tax Credit and advance Child Tax Credit payments using the 2022 CPS ASEC Tax Model and the new survey response on receipt of advance Child Tax Credit payments.

Concluding Remarks

This paper presents a documentation for the CPS ASEC Tax Model. It introduces the history of the Census Bureau's Tax Model. The paper details the methodology, assumptions, and data underlying the model. Specifically, it outlines the process of the CPS ASEC Tax Model in order: the formation the tax filing units, construction of income variables, statistical match to IRS microdata, calculation of federal and state taxes and credits, and requirements for filing. This paper also discusses the limitations of the CPS ASEC Tax Model and presents aggregate statistics of model outputs for comparisons with official tabulations from the Internal Revenue Service. This documentation will continue to be updated to account for future changes in the CPS ASEC Tax Model.

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[24] Due to variations in the timing of receipt of EIP2, potential confusion around the timing of the Third Economic Impact Payment (EIP 3), and high nonresponse rates to the questions, the payments for EIP 1 and EIP 2 are modeled rather than solely relying on the CPS ASEC survey responses. For more information on the imputation of EIP 1 and EIP 2, see Bee, Hokayem, Lin (2021) <https://www.census.gov/content/dam/Census/library/working-papers/2021/demo/sehsd-wp2021-18.pdf>.

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Appendix A[25]

Original Census Tax Model (Before 2004)

Nelson and Feldman (1984) describe the methodology and procedures of the original Census tax model. The original first edition of the tax model simulated taxes in four steps: 1) federal individual income taxes, 2) state individual income taxes, 3) property taxes on owner-occupied housing, and 4) payroll taxes. It utilized economic and demographic information from the March CPS annual demographic supplements,[26] combined with the statistical summaries of individual income returns from the IRS and property taxes from the Annual Housing Survey.

Federal Individual Income Tax

The original model simulated federal individual income taxes in four steps: the formation of filing units, calculation of AGI, calculation of federal taxes paid, and calculation of earned income credits.

Forming Filing Units

Filing units are formed based on household relationships, marital status, and dependency rules. A federal filing unit is assigned to any individual or married couple with either $400 in self-employment income, $1,000 in wages or salary, or a total of $1,000 in interest, dividend, rents and royalties, estate and trusts, or pension income.

The next step was the assigning dependency status. The rules are as follows:
- All primary family householders and spouses were included as dependents on their own tax units
- All children under 15 who are members of the primary family, children over 15 with taxable income of less than $1,000, and children who were students were assigned as dependents to the primary householder.
- All other family member with taxable income less than $1,000 were assigned as dependents to the primary family householder's tax unit.
- Related subfamilies eligible to form their own tax unit were assigned dependents as described for the primary families. Members of related subfamilies without a filing unit were assigned as dependents on the primary tax return.
- Primary and secondary unrelated persons aged 15 and over were treated as dependents on their own tax units.

Married joint filing status was assigned to married persons and those whose spouses were absent in the Armed Forces. Head of household status was assigned to unmarried persons with dependents and to separated married persons with dependents. All other persons meeting the filing criteria were assigned as single filers.

Calculating AGI

AGI was then computed by summing reported income amounts with imputed capital gains. Capital gains were imputed using statistics from the IRS on the number of filers and the aggregate amount of capital gains or losses by AGI class. The proportion of filers with gains or losses could then be determined, and a

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[25] This section follows mostly verbatim from Appendix Three by O'Hara (2004).
[26] This is now the Current Population Survey Annual Social and Economic Supplement (CPS ASEC).

Monte Carlo technique utilized to randomly assign capital gains by multiplying the unit's AGI by the ratio of capital gains to AGI for the appropriate AGI class.

Calculating Federal Taxes

Taxable income was computed by subtracting deductions and exemptions from AGI. A statistical match was performed between the March CPS and Annual Housing Survey to assign a monthly mortgages and property taxes. Probability of itemizing were computed by the size of monthly mortgage payments for homeowners and by AGI level for renters. Itemized deductions were imputed using monthly mortgages (or AGI for renters) in the manner described for capital gains by multiplying AGI the unit's AGI by the ratio of itemized deductions to AGI for the appropriate AGI class.

For non-itemizing returns, the standard deduction was assigned based on the unit's filing status. The exemption amount was based on the number of dependents established during tax unit formation. Total taxes were computed in each year, using the appropriate tax schedule for each return type.

Calculating Federal Tax Credits

The original model simulated four credits to deduct from the total tax liability: 1) the credit for child and dependent care expenses, 2) the child tax credit, 3) the additional child tax credit, and 4) the earned income credit.[27] The dependent childcare expense credit was simulated and deducted from the total tax liability. IRS data on the number and aggregate amount of reported childcare expenses by AGI allowed mean imputation of credit amounts. The child tax credit and additional child tax credit were computed based on IRS rules. The CPS variable FED_TAX reports federal taxes after the tax liability has been adjusted by these credits (1-3). The refundable nature of the additional child tax credit allows FED_TAX to range negative. The final credit simulation is the earned income tax credit. This variable, EIT_CRED, is subtracted from FED_TAX[28] to determine federal taxes after all credits. Computed federal taxes after credits (1-4) could be negative from the refundable additional child tax credit and/or the refundable EITC.

State Individual Income Tax

State income taxes were simulated for states with individual income taxes using the same filing units and AGI determined in the federal simulation.[29] State tax rates and brackets were updated annually. State earned income credits were modeled for some states but not as refundable (thus, state taxes after credits were bounded at zero). Along with Federal taxes, state tax estimates were subtracted from money income to construct alternative income measures for Census Bureau reports.

Property Taxes on Owner-Occupied Housing

Property taxes on owner-occupied housing were simulated using a statistical match to the American Housing Survey. The procedure detailed in the itemizing deduction section of federal taxes simulation. Property taxes are used in determining imputed home equity in one of the alternative income definitions.

Payroll Taxes

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[27] The old model initially only simulated earned income tax credit. The other credits were introduced with new legislation.

[28] The variable is now FEDTAX_AC as of 2021.

[29] Current ASEC Tax Model uses state-specific modified AGI.

Payroll taxes on workers covered under the Federal Insurance Contributions Act (FICA) were computed up to the specified income thresholds ($25,900 in 1980, $87,000 in 2003, and $142,800 in 2021). Payroll taxes on self-employed workers were calculated according to Self-Employment Contributions Act (SECA) rules. These estimates were included in the FICA field. Mandatory retirement payroll deductions for federal employees covered under the Civil Service Retirement System (CSRS) were estimated separately and reported in the FED_RET field.[30]

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[30] FED_RET was discontinued in the 2022 CPS ASEC as only 1.3% of federal employees are still covered under CSRS as of 2021, and the percentage was expected to further decrease.

APPENDIX B

Public Use Tax Model

The public use model differs from the internal model in that it is run on public-use CPS ASEC person and household file. In the past, the public-use and internal Tax Model were two parallel set of programs that were updated independently, which lead to a risk of inconsistency and error during updates. Since the public-use and internal programs are mostly the same, beginning with the 2019 Tax Model, the public-use version and the internal version of the Tax Model programs were merged into one set of SAS programs with a toggle to switch between the public-use and internal sections of the code. Program 00PUBFORMAT is initially run to reformat public use ASEC variables to be consistent with internal ASEC variables prior to running the tax model.