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Estimation of the Underreporting Tax Gap for Tax Years 2014–2016: Methodology

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Table of Contents

Figures and Tables

1 Introduction

This report explains the methodology used to develop the Tax Year (TY) 2014–2016 underreporting tax gap estimates and presents the estimates. The underreporting tax gap components are a major component of the overall gross tax gap. The underreporting tax gap is defined as the amount of tax after refundable and nonrefundable credits that is not voluntarily reported on timely filed returns.

The nature of a concept such as the tax gap makes its estimation difficult and the estimates subject to uncertainty. While the amount of tax reported by taxpayers can be observed, the counterfactual amount of tax that should have been reported by taxpayers needed to estimate the underreporting tax gap is not. The asymmetry of information between taxpayers and the IRS, even with third-party information reporting and the authority to examine books and records to ascertain that the correct tax has been paid, leaves the IRS at a disadvantage in evaluating whether a taxpayer in fact has reported the correct tax. The underreporting tax gap provides an estimate of the level of overall voluntary reporting compliance given all the relevant events that occurred during a tax year and the Internal Revenue Code (IRC) provisions in effect at the time. Tax gap estimates provide the IRS with periodic appraisals about the nature and extent of noncompliance for use in formulating tax administration strategies.

The estimates were prepared by IRS staff using methodologies developed from research and analysis conducted or sponsored by the IRS. Fundamental difficulties in obtaining relevant data and the limitations of other data sources are dealt with in a variety of ways and a set of assumptions underlie the estimates. While we consider the estimates in this report to be accurate and comprehensive, given the inherent uncertainty involved in estimating the tax gap and in the particular set of assumptions chosen, some readers may come to the conclusion that our estimates are too high while others may view them as too low. This report provides detailed information about the approaches and assumptions used to estimate the underreporting tax gap.

Of the $496 billion annual average TY 2014-2016 gross tax gap, $398 billion (approximately 80 percent) is estimated to result from the underreporting of true tax on timely filed returns. The individual income tax underreporting tax gap is $278 billion or 56 percent of the gross tax gap. The corporation income tax underreporting tax gap is about 8 percent, the employment tax underreporting tax gap is about 17 percent, and the estate tax underreporting tax gap is less than one half of one percent of the gross tax gap.

As a share of the underreporting tax gap, the individual income tax underreporting tax gap estimate is about 70 percent of the underreporting tax gap. The corporation income tax underreporting tax gap estimate is about 9 percent, the employment tax underreporting tax gap estimate is about 21 percent, and the estate tax underreporting tax gap is less than one half of one percent of the underreporting tax gap[1].

Chapter 2 of this report covers the underreporting tax gap associated with individual income tax. Chapter 2 also covers the self-employment tax underreporting tax gap. While the self-employment tax underreporting tax gap estimates are included in the overall employment tax underreporting

[1] The component percentages may not sum to 100 percent due to rounding.

tax gap estimate and not in the individual income tax underreporting tax gap estimate, the self-employment tax underreporting tax gap estimates are generated within the individual income tax underreporting tax gap estimation method. Chapter 3 covers the underreporting tax gap associated with small corporations with assets less than $10 million. Chapter 4 covers the underreporting tax gap for large and midsize corporations with assets greater than or equal to $10 million. Chapter 5 covers the underreporting tax gap for social security and Medicare taxes under the Federal Insurance Contributions Act (FICA) and payments for federal unemployment insurance under the Federal Unemployment Tax Act (FUTA). And lastly, Chapter 6 covers the underreporting tax gap for the estate tax.

2 Estimates of the Tax Year 2014–2016 Individual Income Tax Underreporting Tax Gap

2.1 Introduction

This chapter covers the methodology and estimates of the average annual underreported individual income tax and self-employment tax on timely filed returns for the tax year 2014–2016 timeframe.[2] Individual income taxes were underreported by an estimated $278 billion, representing 17 percent of the amount of individual income taxes that should have been reported on returns that were filed on time. Self-employment taxes were underreported by an estimated $53 billion, 50 percent of the amount that should have been reported on individual income tax returns that were filed on time. The tax gap estimates show that as third-party information reporting increases, underreporting of that income tends to decrease. Only 6 percent of income subject to substantial information reporting (but not withholding) was underreported, while 55 percent of income subject to little or no information reporting was underreported.[3]

The individual income tax underreporting tax gap estimate is not a tallying of observed misreported taxes across all individual returns. Instead, misreported individual income taxes for the population are estimated from a statistically representative sample of individual income tax returns. Although the sample is representative of the population of individual income tax returns, misreported income detected during the course of the audits of the sample returns most likely did not account for all of the income that should have been reported on the returns. In order to account for all underreporting, the amount of income that was not detected during the audits is estimated using an econometric technique called Detection Controlled Estimation (DCE). The remainder of this chapter describes in greater detail the data and methodology used to estimate the TY 2014–2016 individual income tax underreporting tax gap, including the DCE methodology. It first highlights what is new for the TY 2014–2016 estimates. It is followed by an overview of the new estimates and ends with additional detail on the data and estimation methods.

2.2 New for the Tax Year 2014–2016 Estimates

2.2.1 Updated Data

The TY 2014–2016 individual income tax underreporting tax gap reflects new data from the National Research Program (NRP) for tax years 2014–2016.

2.2.2 Updated Detection Controlled Estimation

Like prior tax gap estimates, the TY 2014–2016 individual income tax underreporting tax gap estimates include estimates of underreported taxes associated with estimated unreported income that was not detected during the examination. Consistent with the TY 2011–2013 individual

[2] Estimates of the amount of underreported income and the percentage of underreported income reflect underreported income net of overreported income. Individual income taxes reported (and underreported) on returns filed after the applicable filing deadline, including any valid extensions, are part of the individual income tax nonfiling tax gap.

[3] Income subject to substantial information reporting (but not mandatory withholding) includes dividend income, interest income, pensions and annuities, social security benefits, unemployment insurance, and state income tax refunds. Income subject to little or no information reporting includes nonfarm sole proprietor income reported on Schedule C, farm income reported on Schedule F, rental and royalty income reported on Schedule E, Form 4797 income, and income reported on the "other income" Form 1040 line.

income tax underreporting tax gap estimates, data contemporaneous with the tax gap estimates was used to estimate undetected unreported income. TY 2014–2016 NRP data was available, however, the NRP study for TY 2016 was limited to the following returns:

(1) returns that claimed the refundable or nonrefundable American Opportunity Tax Credit (AOTC)
(2) returns that claimed the refundable or nonrefundable Child Tax Credit (CTC)
(3) returns that claimed the Earned Income Tax Credit (EITC)
(4) return that claimed the Net Premium Tax Credit (Net PTC)
(5) returns required to reconcile the Premium Tax Credit (PTC) with the Advance Premium Tax Credit (APTC)

Therefore, only TY 2014 and TY 2015 NRP data were used to update the DCE econometric technique in order to estimate undetected income. The estimated coefficients on the detection equations from the updated DCE estimates were assumed to apply to the TY 2016 NRP data.

2.3 Estimates for TY 2014–2016

Table 2-1 shows the estimated tax gap by individual income tax component for TY 2014–2016, TY 2011–2013, TY 2008–2010, and TY 2006. Business income that should have been reported on Schedules C, E, and F accounted for 47 percent of the total individual income tax underreporting tax gap for TY 2014–2016. Relative to TY 2011–2013, credits remained at $42 billion but decreased as a share of the individual income tax underreporting tax gap from 17 percent to 15 percent.

Table 2-1: Individual Income Tax and Self-Employment Tax Underreporting Tax Gap Estimates for Tax Years 2006, 2008–2010, 2011–2013 and 2014–2016
[Money amounts are in billions of dollars].

Tax Gap Component	TY2014 - TY2016[1]	TY2011 - TY2013[1]	TY2008 - TY2010[1]	TY 2006
Individual Income Tax	**$278**	**$245**	**$264**	**$235**
Non-Business Income[2]	60	57	64	68
Business Income[3]	130	110	125	122
Adjustments, Deductions, Exemptions	25	20	19	17
Filing Status	5	5	5	
Other Taxes	4	1	1	
Unallocated Marginal Effects	11	10	12	
Credits	42	42	40	28
Self-Employment Tax[4]	**53**	**45**	**65**	**57**

[1] Estimates reflect an annual weighted average for the associated three-year time period. For the TY 2014–2016 estimate, TY 2016 is only reflected for certain credits and other taxes. All other lines for TY 2014–2016 reflect TY 2014–2015.
[2] Includes all income except Schedules C, E, and F.
[3] Income from Schedules C, E, and F.
[4] TY 2011–2013 and TY 2014–2016 include up to $1 billion of uncollected FICA and unemployment taxes on wages and tips.
NOTE: Components might not sum to totals because of rounding.

2.3.1 Information Reporting and Individual Income Tax Reporting Compliance

Tables 2-2 and 2-3 show the relationship between the degree of third-party information reporting and individual income tax reporting compliance using tax gap estimates and net misreporting percentage (NMP) estimates. The NMP is a ratio measure incorporating amounts misreported and amounts that should have been reported. The definition accounts for the fact that certain tax return line items can be negative and that amounts can be overreported or underreported. The net misreporting percentage (NMP) is defined as the sum of the net misreported amount (NMA) divided by the sum of the absolute values of the amounts that should have been reported. The NMA is the difference between the amount that that should have been reported and the amount that was reported and it is the net of overreporting and underreporting. The sign convention of the NMA is different for income and taxes versus offsets to income and credits. The NMA is positive whenever income and taxes are underreported and negative whenever those items are overreported. Conversely, the NMA is positive whenever offsets to income and credits are overreported and negative whenever those items are underreported. In that sense, positive NMA and NMP generally indicate that errors on a given line were typically made in the taxpayers' favor, meaning less tax (or more credits) was reported than should have been.

Although Table 2-3 seems to indicate an increase in the NMP with respect to credits relative to TY 2008–2010, the increase in the NMP is primarily a factor of the sunsetting of the Making Work Pay Credit. The Making Work Pay Credit was a temporary refundable credit applicable only in tax years 2009 and 2010 and accounted for over $50 billion of refundable tax credits each of those

tax years. The Making Work Pay Credit applied to a broad base of taxpayers and had a very low net misreporting percentage. The size of the Making Work Pay Credit and low noncompliance rate drove down the estimated net misreporting percentage for the total credits category.

Table 2-2: Tax Gap by Tax Return Line Item Categories: Tax Years 2006, 2008–2010, 2011–2013 and 2014–2016

[Money amounts are in billions of dollars]

Tax Return Line Items Grouped by Visibility Category	Tax Gap			
	TY2014 - TY2016[1]	TY2011 - TY2013[1]	TY2008 - TY2010[1]	TY2006
Individual Income Tax	**$278**	**$245**	**$264**	**$235**
Substantial Information Reporting and Withholding[2]	7	9	5	11
Substantial Information Reporting[3]	15	12	15	12
Some Information Reporting[4]	43	36	33	
Prior Definition	*72*	*59*	*57*	*64*
Little or No Information Reporting[5]	126	109	136	
Prior Definition	*121*	*106*	*130*	*120*
Adjustments, Deductions, Exemptions	25	20	19	17
Filing Status	5	5	5	
Other Taxes	4	1	1	
Unallocated Marginal Effects	11	10	12	
Credits	42	42	40	28

[1] Estimates reflect an annual weighted average for the associated three-year time period. For the TY 2014–2016 estimate, TY 2016 is only reflected for certain credits and other taxes. All other lines for TY 2014–2016 reflect TY 2014–2015.

[2] Wages and salaries

[3] Pensions & annuities, unemployment compensation, dividend income, interest income, and taxable social security benefits.

[4] Current definition includes partnership/S corp. income, capital gains, alimony income. Prior definition added deductions and the exemption amount to the current definition.

[5] Current definition sums Nonfarm proprietor income, other income, rents and royalties, farm income, Form 4797 income. Prior definition added adjustments to income to the current definition.

NOTE: Components might not sum to totals because of rounding.

Table 2-3: Net Misreporting Percentage by Tax Return Line Item Categories: Tax Years 2006, 2008–2010, 2011–2013 and 2014–2016

Tax Return Line Items Grouped by Visibility Category	Net Misreporting Percentage[1]			
	TY2014 - TY2016[2]	TY2011 - TY2013[2]	TY2008 – TY2010[2]	TY2006
Individual Income Tax	**17%**	**18%**	**22%**	**19%**
Substantial Information Reporting and Withholding[3]	1%	1%	1%	1%
Substantial Information Reporting[4]	6%	5%	7%	8%
Some Information Reporting[5]	15%	17%	19%	
Prior Definition	*10%*	*10%*	*10%*	*11%*
Little or No Information Reporting[6]	55%	55%	63%	
Prior Definition	*48%*	*48%*	*55%*	*56%*
Adjustments, Deductions, Exemptions	6%	5%	5%	
Credits	38%	38%	26%	37%

[1] Net misreporting percentage is the net misreported amount divided by the sum of the absolute values of the amounts that should have been reported. For income visibility categories the NMP refers to the net misreported percentage of income; not the taxes associated with that income.

[2] Estimates reflect an annual weighted average for the associated three-year time period. For the TY 2014-2016 estimate, TY 2016 is only reflected for certain credits and other taxes. All other lines for TY 2014-2016 reflect TY 2014 - 2015.

[3] Wages and salaries

[4] Pensions & annuities, unemployment compensation, dividend income, interest income, and taxable social security benefits.

[5] Current definition includes partnership/S corp. income, capital gains, alimony income. Prior definition added deductions and the exemption amount to the current definition.

[6] Current definition sums Nonfarm proprietor income, other income, rents and royalties, farm income, Form 4797 income. Prior definition added adjustments to income to the current definition.

NOTE: Components might not sum to totals because of rounding.

Tables 2-4 further disaggregates the TY 2014–2016 individual income tax underreporting tax gap into specific line items (or groupings of line items) from the individual income tax return. Note that the self-employment tax *deduction* is underreported because self-employment income and therefore self-employment tax is underreported. Table 2-5 provides additional detail on tax credits including the measure called the net overclaim rate (NOR). The net overclaim rate is similar to the net misreporting percentage with the net misreported amount in the numerator. However, the NOR uses the amount reported in the denominator instead of the absolute value of the amount that should have been reported. For tax credits, the NOR may be a more intuitive measure in that it reflects the total amount overclaimed net of the total amount underclaimed as a percentage of the amount reported. Table 2-6 shows the self-employment tax underreporting tax gap and associated NMP.

Table 2-4: Individual Income Tax Underreporting Tax Gap by Source for TY 2014–2016
(Money amounts are in billions of dollars)

Tax Return Line Items	Tax Gap	Share of Individual Income Tax Underreporting Tax Gap	Net Misreporting Percentage[2]
Individual Income Tax Underreporting Tax Gap	**$278**	**100%**	**17%**
Items Subject to Substantial Information Reporting and Withholding	**$7**	**2%**	**1%**
Wages, salaries, tips	$7	2%	1%
Items Subject to Substantial Information Reporting	**$15**	**5%**	**6%**
Interest income	$1	[3]	4%
Dividend income	$1	[3]	4%
State income tax refunds	$1	[3]	9%
Pensions & annuities	$7	2%	4%
Unemployment compensation	[3]	[3]	12%
Taxable Social Security benefits	$6	2%	13%
Items Subject to Some Information Reporting	**$43**	**15%**	**15%**
Partnership, S-Corp, Estate & Trust, etc.	$25	9%	12%
Alimony income	[4]	[4]	[4]
Capital gains	$18	6%	18%
Short-term capital gains	*$6*	*2%*	*17%*
Long-term capital gains	*$12*	*4%*	*16%*
Items Subject to Little or No Information Reporting	**$126**	**45%**	**55%**
Form 4797 income	$4	1%	35%
Other income	$16	6%	42%
Nonfarm proprietor income	$80	29%	57%
Farm income	$5	2%	64%
Rents & royalties	$21	7%	53%
Adjustments, Deductions, Exemptions	**$25**	**9%**	**6%**
Total statutory adjustments	-$5	-2%	-13%
Self-employment tax deduction	-$6	-2%	-50%
All other adjustments	$1	[3]	5%
Deductions	$22	8%	7%
Exemptions	$8	3%	6%
Filing Status	**$5**	**2%**	**n.a.**
Other Taxes	**$4**	**1%**	**6%**
Unallocated Marginal Effects	**$11**	**4%**	**n.a.**
Total Credits	**$42**	**15%**	**38%**

[1] Estimates reflect an annual weighted average for the associated three-year time period. For the TY 2014–2016 estimate, TY 2016 is only reflected for certain credits and other taxes. All other lines for TY 2014–2016 reflect TY 2014 – 2015.

[2] The net misreporting percentage is the net misreported amount divided by the sum of the absolute values of the amounts that should have been reported, expressed as a percentage.

[3] Less than 0.5 percent or $0.5 billion.

[4] Estimate is based on very small sample size. Estimated tax gap is less than $ 0.5 billion and NMP is less than 0.5%.

n.a : not applicable.

Detail may not add to total due to rounding.

As Tables 2-3 and 2-4 show, reporting compliance increases (reflected in a lower NMP) with the comprehensiveness of third-party information reporting. The NMP for income amounts subject to substantial information reporting and withholding is 1 percent, for income amounts subject to substantial information reporting but not withholding is 6 percent; for income amounts subject to some information reporting is 15 percent; and for income amounts subject to little or no information reporting, such as nonfarm proprietor income, is 55 percent.

Table 2-5 shows that overreported Earned Income Tax Credit (EITC) continues to be one of the largest contributors to individual income tax underreporting tax gap. EITC accounts for 10 percent of the individual income tax underreporting tax gap; second only to nonfarm proprietor income that contributes 29 percent.

Table 2-5: Tax Gap by Type of Credit for Tax Years 2014–2016

Tax Return Line Items	Tax Gap	Share of Individual Income Tax Underreporting Tax Gap	Net Overclaim Percentage[3]
Total Individual Underreporting Gap	**$278**	**100%**	**N/A**
Total Credits	**$42**	**15%**	**28%**
Child Tax Credit and Additional Child Tax Credit	$8	3%	16%
Earned Income Tax Credit	$28	10%	45%
Education Credits	$5	2%	24%
All Other Credits	$2	1%	5%

[1] Estimates reflect an annual weighted average for the associated three-year time period. For the TY 2014–2016 estimate, TY 2016 is only reflected for certain credits and other taxes. All other lines for TY 2014–2016 reflect TY 2014 – 2015.

[2] Less than 0.5 percent.

[3] Net Overclaim Percentage (NOP) is the ratio of the net misreported amount to the amount reported.

Table 2-6: Self-Employment Tax Gap and Net Misreporting Percentages for Tax Years 2014–2016

[Money amounts are in billions of dollars][1]

	Tax Gap	Net Misreporting Percentage[2]
Self-Employment Tax[3]	**$ 53**	**50%**

[1] Estimates reflect an annual weighted average for the period TY 2011–2013
[2] The net misreporting percentage is the net misreported amount divided by the sum of the absolute values of the amounts that should have been reported.
[3] TY2014 – TY2016 includes less than $0.5 billion of uncollected FICA and unemployment taxes on wages and tips.

2.4 Data and Estimation Methods: National Research Program

The IRS National Research Program (NRP) designs and administers reporting compliance studies for the IRS.[4] NRP is an examination program where returns are selected for audit in a statistical manner that allows one to draw inferences about the population from the results of those audits. The purpose of a given NRP audit is to ascertain the correctness of the return examined and determine the correct liability. The first NRP study of individual income tax reporting compliance consisted of a stratified random sample of about 45,000 TY 2001 individual income tax returns filed during calendar year 2002.[5] That study served as the basis for the TY 2001 individual income tax underreporting tax gap estimates. Beginning with TY 2006, the IRS began smaller annual samples of approximately 14,000 individual income tax returns. The annual studies can be combined over several years to provide compliance estimates at a similar level of reliability as a single-year larger study. Data for a given tax year generally are available for analysis purposes about three years after the returns are filed.

NRP uses a process called classification to determine the type of audit for each return selected and the mandatory issues to be examined.[6] The classification process compares information return documents (Form W-2, Form 1099, etc.) with the actual tax return in order to identify potential discrepancies and also identifies items that appear large, unusual, or questionable. Some line items on the return, typically those that cannot be verified through information returns, are always classified as mandatory to audit. In the case of simpler returns where information can be reconciled with third-party information and there appears to be a low likelihood that items are missing from the return, taxpayers are not audited and not even contacted. Returns that have only a small number of simple issues identified in classification are routed to campus correspondence examinations where the examination can be handled through telephone calls, faxes, and traditional mail. More complicated returns are assigned to one of two types of audits that involve face-to-face interaction with an examiner: either an office audit handled by a Tax Compliance Officer (TCO) or a field audit handled by a Revenue Agent (RA) who may visit the taxpayer's place of business.

The classification process, by selecting an appropriate audit technique and set of issues, serves to reach an appropriate balance among the objectives of ensuring the taxpayer reported the correct liability, obtaining comprehensive and reliable information about reporting compliance, and taxpayer and examiner effort involved in an examination. The number of mandatory issues on an NRP-selected audit typically exceeds the number of issues that would have been examined had the return been selected through another IRS compliance risk-based return selection process. The audits selected through these latter programs generally are more limited in the scope of issues covered compared with those covered in the audits selected under NRP. NRP audits, therefore, are more complete audits, which is beneficial for ascertaining the accuracy of the return and determining the correct tax liability. Examiners also have the discretion to expand the audit to

[4] NRP conducts more than just individual income tax reporting compliance studies. It should be assumed for the remainder of this chapter that references to an NRP study refers to an individual income tax reporting compliance study unless explicitly stated otherwise.

[5] The TY 2001 individual income tax reporting compliance study consisted of returns with tax periods ending between July 2001 and June 2002, the overwhelming majority of which ended on December 31, 2001 and were filed in early 2002.

[6] Examples of issues include line items on the return, filing status, number of dependents, whether an activity is engaged in for profit or as a hobby.

include non-classified issues, typically whenever information is uncovered during the course of the audit that causes the examiner to question those issues.

2.5 Data and Estimation Methods: Detection Controlled Estimation (DCE)

Not all underreported income is detected by every audit, even ones of the scope and quality of NRP audits. This was confirmed by the 1976 IRS Taxpayer Compliance Measurement Program (TCMP) individual income tax reporting compliance study, which was the last IRS reporting compliance study to audit taxpayers without the auditors having the use of third-party information return documents. The IRS later compared the information return documents to the audit findings and found that for every $1.00 of detected unreported income that was reported on information documents, an additional $2.28 went undetected.[7] As a result of that study, the IRS began multiplying the portion of income detected without the use of information documents by a multiplier, typically 3.28, in order to estimate the individual income tax underreporting tax gap.

In the late 1980s, Jonathan Feinstein developed an econometric technique for estimating undetected income that he termed "detection controlled estimation" or DCE.[8] The intuition behind the methodology was that examiners have varying abilities for detecting income that can be observed through patterns in the data collected from taxpayer audits. Feinstein explained that the observed audit adjustment actually reflects the product of the true (unobserved) unreported income and the propensity of the examiner to detect unreported income. Feinstein's application of the methodology to TCMP data resulted in comparable estimates for the amount of undetected income as the IRS was assuming based on the 1976 TCMP study. The original DCE methodology focused on estimating overall noncompliance for a given return. Because the IRS was also interested in the sources of noncompliance, the former IRS Office of Research contracted with Dr. Brian Erard (B. Erard and Associates) and Professor Feinstein (Yale School of Management) to extend and refine Professor Feinstein's original DCE methodology.[9]

2.5.1 DCE Implementation for the TY 2001 Tax Gap Estimates

The TY 2001 tax gap estimates incorporated DCE estimation for the first time. The first iteration of DCE using the TY 2001 NRP data involved DCE estimation for two categories of income separately for two categories of taxpayers. The results were then synthesized down to four "multipliers" that were then applied to positive adjustments made on face-to-face audits. Table 2-7 shows the four multipliers and the respective line item categories and return groupings based on the presence of business income and level of Total Positive Income (TPI).

[7] See Internal Revenue Service (1983) and Internal Revenue Service (1988) for a discussion of the 1976 Information Return Program document matching study and the derivation of the multipliers applied to TCMP audit results.
[8] See Feinstein (1990, 1991).
[9] See B. Erard & Associates (2005, 2006, 2007, 2011 and 2014) and Erard and Feinstein (2011).

Table 2-7: Multipliers Used to Estimate Undetected Individual Income for TY 2001

Income Category	*TY 2001 NRP DCE Multipliers*	
	Non-Business Return and TPI < $100K	***TPI ≥ $100K or Business Return***
"High Visibility" Income • Wages, salaries, tips • Interest & dividends • State tax refunds • Alimony • Capital gains • Pensions • Unemployment compensation • Social Security income	2.009	2.340
"Low Visibility" Income • Farm or non-farm proprietor income • Partnership or S-Corp income • Rents & royalties • Other income • Form 4797 income	4.158	3.348

2.5.2 DCE Implementation for the TY 2006 Tax Gap Estimates

Further research determined that there was an opportunity to expand DCE estimation to allow for greater variability in the average detection rates across line items.[10] The TY 2001 data were again used for DCE estimation, but the methodology was expanded to allow for increased line item estimation beyond the initial groupings used for the first iteration for the TY 2001 estimates. The results of the second iteration of DCE estimation using the TY 2001 NRP data was incorporated into the TY 2006 tax gap estimates. At the time of the release of the TY 2006 tax gap estimates, there was not sufficient TY 2006 and later NRP data available to estimate DCE using contemporaneous data. Therefore, the IRS developed an imputation methodology to impute estimates of undetected income derived from the TY 2001 data to the TY 2006 NRP data[11].

The primary purpose of the DCE estimation is to estimate how much underreported income was not detected on the NRP audits. Under the assumption that the average propensity of examiners to detect underreported income remained stable between the TY 2001 and TY 2006 NRP studies, the detected underreported income from the TY 2006 NRP data could still provide much of the information needed for estimating the TY 2006 individual income tax underreporting gap. The imputation of undetected income from the TY 2001 NRP data to the TY 2006 NRP data took place over two stages. The first stage generated 10 simulated TY 2001 NRP data sets with return level

[10] Detection rate here is defined as the amount of unreported income detected as a percentage of the total unreported income. The smaller the detection rate, the larger the amount of total underreporting is relative to detected underreporting.

[11] For further discussion on the imputation methodology for the TY 2006 tax gap estimates, see Bloomquist, et al. (2012) *Estimates of the Tax Year 2006 Individual Income Tax Underreporting Gap* at https://www.irs.gov/pub/irs-soi/12resconEstimates.pdf

predictions of undetected income. During the second stage, those 10 simulated TY 2001 data sets were used to generate 10 simulated TY 2006 NRP data sets with return level predictions of undetected income.

The imputation of TY 2001 DCE estimation results to the TY 2006 NRP data relied upon the following assumptions:

(1) if income was reported for the line item, detection was assumed to vary with the amount of the line item that was reported,
(2) if income was not reported for the line item, detection was assumed to vary with the amount of adjusted gross income (AGI) that was reported.

The updated imputation methodology did not rely on multipliers, instead the estimated conditional mean amount of undetected income was imputed to the NRP returns through the simulation approach.

2.5.3 DCE Implementation for the TY 2008–2010 Tax Gap Estimates

The first iteration of DCE estimation using the smaller annual NRP study data required pooling the TY 2006–2008 NRP data. Since the TY 2006 NRP sample is less than a third of the size of the TY 2001 study, TY 2006–2008 data were pooled in order to provide a sufficient number of observations. Due to the time and expertise that DCE estimation requires, the TY 2009 and TY 2010 NRP data were not available for the initial DCE estimation. Therefore, IRS again had to impute estimates of undetected income from the TY 2006–2008 DCE estimation to the TY 2008–2010 NRP data for purposes of estimating the TY 2008–2010 individual income tax underreporting tax gap.

The imputation categories used for imputing DCE estimates from the TY 2006–2008 data to TY 2008–2010 better reflected the assumptions and structure of the design of the DCE estimation methodology relative to the prior applications of an imputation methodology. In particular, the imputation categories for the TY 2006 tax gap estimates focused on deciles of the amounts reported and Adjusted Gross Income (AGI) reported. The updated imputation categories linked detection to Information Return (IR) document discrepancies, line item classification outcomes, line item reporting, and whether or not underreporting was initially detected. The imputation was implemented using a simulation approach similar to that previously used for the TY 2006 tax gap estimates, except the assumptions and imputation categories were better aligned with the underlying design of the DCE estimation methodology.

2.5.4 DCE Implementation for the TY 2011 – 2013 Tax Gap Estimates

For the first time since the Tax Year 2001 tax gap estimates, data contemporaneous with the tax gap estimates was used to estimate undetected unreported income for the TY 2011–2013 individual income tax underreporting tax gap estimates. TY 2011–2013 NRP data were available for DCE estimation of undetected income. Unlike the TY 2006 and TY 2008–2010 tax gap estimates, it was not necessary to impute estimates of undetected income from prior NRP studies. Instead, the actual line item predictions for each NRP return could be used directly for tax gap estimation. NRP data from TYs 2008–2013 were used for DCE estimation for all line items except Schedule C and F. TY 2006–2013 NRP data were used for Schedules C and F.

2.5.5 DCE Implementation for the TY 2014–2016 Tax Gap Estimates

NRP data from TYs 2011–2015 were used to estimate DCE for each line item or grouping of line items for the TY 2014–2016 individual income tax underreporting tax gap estimates. The TY 2014–2016 DCE implementation followed the same methodology as the TY 2011–2013 DCE implementation using the updated NRP data. The TY 2016 NRP individual income tax reporting compliance study was a limited study that focused only on returns that claimed certain credits or that had to reconcile Advance Premium Tax Credit (APTC) payments with the Premium Tax Credit (PTC). Given the limited scope of the TY 2016 NRP study, the data were not suitable for including in the DCE estimation. However, one might expect that detection rates for TY 2016 would be similar to the estimated detection rates from the TY 2011–2015 NRP samples. Undetected income for TY 2016 was estimated by assuming the parameters from the estimated DCE equations were applicable to the TY 2016 NRP data.

DCE estimation requires explicit modeling of a detection equation whose arguments include the type of examiner (TCO or RA), the experience of the examiner, and binary variables that take the value of 0 or 1 to indicate which examiner conducted the exam. In order to differentiate the detection capabilities of different examiners, the examiners included in the detection equation must have audited a sufficient number of returns with the income item being modeled. Typically, this requirement is 15 or more returns.

The DCE methodology includes a two-part specification for modeling the noncompliance of a line item. The first noncompliance equation models the likelihood of noncompliance while the second equation models the magnitude of noncompliance conditional on the presence of noncompliance. Since some income items with significant information reporting were not routinely classified, the extension also included additional modeling conditional on whether or not the line item was classified and on mismatches with information documents for these items.

The data requirements for DCE meant that some income items still needed to be grouped together for purposes of estimating the detection equation, even when using NRP data pooled across multiple years. Table 2-8 shows the specific groupings of income items used for estimation. Income items that were routinely classified (typically because of the lack of complete information reporting) were modeled separately from items subject to significant information reporting (wages, interest income, etc.). Schedule C and F income were primarily estimated independent of each other and of other routinely classified income items. Other routinely classified income items (capital gains, rental and royalty income, partnership and S corporation income, etc.) were estimated jointly with a common detection equation. Similarly, items that were not routinely classified (typically these items are subject to significant information reporting) were also estimated jointly with a common detection equation. This is the same groupings of income items that was used for the TY 2006–2008, TY 2008–2010, and TY 2011–2013 DCE estimation.

Table 2-8: Grouping of Income Items for Joint Estimation

Items Not Routinely Classified	Items Routinely Classified	
Estimated Jointly	***Estimated Jointly***	***Estimated Separately***
Wages and Salaries	Short-term Cap Gains	Schedule C
Interest	Long-term Cap Gains	Schedule F
Dividends	Rents and Royalties	
State and Local Tax Refunds	Part., S corp., Estate, Other	
Pensions and IRAs	Form 4797 Net Gains	
Gross Social Security	Other Income	
Unemployment		

2.5.6 Simulation of Undetected Income

The DCE formula underlying the return level predictions predicts a positive probability of undetected income for most returns (though this is typically very small for returns where no unreported income was detected). Simply multiplying the predicted probability of undetected income by the predicted magnitude of undetected income would result in nearly every return receiving some positive amount of undetected income for each income item, but that would not produce a realistic distribution of undetected income. A small probability of undetected income for an income item actually means that undetected income would be present on a relatively small number of returns for that item. In order to have a more realistic allocation of undetected income, a simulation approach is used to apply the DCE prediction formulas. The simulation process randomly allocates undetected income for a given income item based on the probability of undetected income for that item on each return.

The specific steps of the first stage of the simulation are described below.

For each return:

Step 1: Calculate the predicted probability of the presence of undetected income conditional on whether unreported income was detected by the examiner.

Step 2: Calculate the predicted magnitude of total unreported income conditional on the presence of undetected income.

Step 3: Draw a random number between 0 and 1.

Step 4: If the random number is less than or equal to the predicted probability from Step 1, allocate the predicted total (detected + undetected) amount of unreported income from Step 2. Otherwise, allocate only the detected amount of unreported income (if any).

Step 5: Calculate the weighted sum of predicted total unreported income from Step 4 across all returns to estimate unreported income for the population.

Steps 3 to 5 were repeated ten times for each income item to create ten sets of pooled NRP TY 2011–2013 NRP data with simulated undetected income.

2.5.6.1 Tip Income Adjustments

DCE is unlikely to fully account for all undetected tip income. Since tip income is relatively concentrated in a few industries and occupations, tip income represents a relatively small amount of overall wages, salaries, and tips. However, since a significant portion of tip income is paid in cash by customers, tip income is subject to less information reporting than most wages and salaries. The lack of complete information reporting and the cash nature of tips suggest that tip income had a lower compliance rate than other wages and salaries and was harder to detect during an audit. Given the concentration of tip income and the nature of the NRP samples, DCE estimation did not support estimates of unreported tip income. Unreported tip income was assumed to have the same noncompliance rate as the detected noncompliance rate for sole proprietor net income or loss. Thus, reported tip income was multiplied by an adjustment factor based on sole proprietor net income or loss estimates to estimate unreported tip income.

2.6 Data and Estimation Methods: Tax Calculator

To estimate underreported taxes resulting from the underreported income at the line item level, a tax calculator was applied to individual observations (i.e. tax returns) from the ten simulated TY 2014–2016 NRP data sets. This process provided ten underreporting tax gap estimates for each line item which were then averaged to produce the final underreporting tax gap estimate. The final line item underreporting tax gap estimates were summed to estimate the overall individual income tax underreporting tax gap. The specific process for estimating the underreporting tax gap for each line item using the tax calculator is described below. As an example, the additional income for each income item was added (or subtracted) to the reported amount of income and then tentative tax was calculated. Then that additional income was dropped, and the process was repeated for the next income item.

The following steps were applied to the first simulated TY 2014–2016 NRP data set:

Income Items

Step 1: Calculate tentative tax based on reported income, deductions, exemptions, and filing status.

Step 2: Add net misreported wages, salaries, and tips and recalculate tentative tax.

Step 3: Subtract tentative tax calculated in Step 1 from tentative tax calculated in Step 2. This generates an estimate of the underreporting tax gap for wages, salaries, and tips from the first simulated data set.

Step 4: Remove the unreported wages, salaries, and tips added during Step 2.

Step 5: Repeat Steps 2 to 4 for the remaining income items.

Adjustments to Income, Deductions and Exemptions

Step 1: Calculate tentative tax based on reported and net misreported income, reported deductions, reported exemptions, and reported filing status.

Step 2: Add net misreported adjustments to income (other than the deduction for one-half of self-employment tax) and calculate tentative tax.

Step 3: Subtract tentative tax calculated in Step 1 from tentative tax calculated in Step 2. This generates an estimate of the underreporting tax gap for adjustments to income.

Step 4: Incrementally repeat steps 2 and 3 for the one-half of self-employment tax deduction, total deductions (itemized and standard), and the exemption amount.

Filing Status

Step 1: Calculate tentative tax based on reported and net misreported income, reported and net misreported deductions, reported and net misreported exemptions, and reported filing status.

Step 2: Calculate tentative tax based on reported and net misreported income, reported and net misreported deductions, reported and net misreported exemptions and the filing status that should have been reported.

Step 3: Subtract tentative tax calculated in Step 1 from tentative tax calculated in Step 2. This generates an estimate of the underreporting tax gap associated with errors in filing status.

Credits

Step 1: Calculate refundable and nonrefundable credits based on reported income, reported deductions, reported exemptions, and reported filing status

Step 2: Calculate refundable and nonrefundable credits based on reported and net misreported income, reported and net misreported deductions, reported and net misreported exemptions and the filing status that should have been reported.

Step 3: Subtract credits calculated in Step 2 from credits calculated in Step 1. This generates an estimate of the underreporting tax gap for total credits from the first simulated data set.

These steps are then repeated for the remaining nine simulated TY 2014–2016 NRP data sets.

2.6.1 Self-Employment Taxes

Self-employment taxes are required to be reported by individuals with self-employment income on individual income tax returns. The underreporting of self-employment income (primarily income reported on Schedules C and F) results in underreported self-employment taxes. Each spouse on a joint return has a separate earned income threshold above which the combined wages and self-employment income are subject to Medicare taxes but not Social Security taxes. Undetected self-employment income (Schedules C and F) was allocated to the primary taxpayer and secondary taxpayer according to each taxpayer's respective share of self-employment income as determined by the examiner. Undetected wages, salaries, and tips were allocated similarly. The tax calculator then calculated the amount of self-employment taxes that should have been reported.

2.7 Data and Estimation Method: Differences Between EITC Improper Payment Estimates and Tax Gap Estimates

The estimates of EITC improper payments published in the Department of Treasury Agency Financial Report (AFR) differ from the tax gap estimates associated with EITC, ACTC and the refundable AOTC. This section explains the differences between tax gap and improper payment methodologies. The Improper Payment Information Act of 2002 (IPIA) and subsequent legislation and OMB guidance established requirements related to the estimation and reporting of "improper payments" and actions to reduce them for programs meeting certain requirements. OMB guidance with respect to the original IPIA required improper payments reporting for agencies and programs that were covered by Section 57 of OMB Circular A-11 and that Circular included the EITC. IRS subsequently began reporting improper payment estimates for ACTC and the refundable AOTC. As one component in a portfolio of tax compliance-related research, the IRS has issued tax gap estimates on a periodic basis since 1983, predating any improper payments legislation or guidance.

2.7.1 Audit Nonresponse

One of the key differences centers on the uncertainty around the true EITC eligibility for taxpayers who do not show for the scheduled audit interview or respond to the audit notice (hereafter referred to as "taxpayer's who do not respond" for convenience). The improper payment estimates assume that taxpayers who do not respond have similar compliance as responding taxpayers with similar characteristics. Implicit in that assumption is the belief that the actual audit outcome does not reflect the amount of EITC that the taxpayer would have been allowed had the taxpayer responded. Unlike the improper payments estimates, tax gap estimates assume that the examiner recommended adjustments are the best estimate of the true amount of EITC, subject to the DCE-based adjustments for undetected income described below. Since for EITC examiners typically disallow the full amount of EITC whenever taxpayers do not respond despite multiple notices and attempts to engage the taxpayer, the audit outcome for EITC for these taxpayers is typically zero.

2.7.2 Effect of Undetected Income on EITC Tax Gap Estimates

The improper payment estimates assume that examiners are able to detect all misreported income by the taxpayers. As previously discussed, the tax gap methodology estimates the amount of unreported income that examiners do not detect. The burden of proof for establishing unreported income lies with the examiner who, in the absence of complete third-party information reporting, likely lacks all of the knowledge and facts surrounding the taxpayer's income. The estimated true amount of EITC under the tax gap methodology is calculated based on the additional income as detected by the examiner plus the unreported income that the examiner did not detect that we estimate using DCE.

2.7.3 Protected Revenue

The last major difference between the improper payment estimates and tax gap estimates concerns revenue protected. In the context of the EITC, revenue protected is the amount of overclaimed EITC that was identified at the time of filing as potentially erroneous and then not paid out as part of the tax refund pending taxpayer validation of the EITC claim. The revenue protected is the amount of EITC that was held—or "frozen" in IRS terminology—and then subsequently determined to have been claimed in error and not paid out. The EITC improper payment estimates reflect the amount of overclaimed EITC[12] net of prevented improper payments while the EITC tax gap estimates reflect the gross amount of net misreported EITC (both overreported and underreported EITC) and *do not* subtract off prevented improper payments.

2.8 Data and Estimation Methods: Effect of Undetected Income on the Estimates

Tables 2-9 and 2-10 show estimates of the TY 2014–2016 individual income tax underreporting tax gap before the imputation of undetected income (based on the examiner detected misreporting) and the final tax gap estimates after imputation of undetected income.

[12] The improper payment estimates add underpayment to overpayments but EITC underpayments as defined for IPIA are negligible. Improper payment underpayments are conceptually different from underclaims in that the former can exist only if there is an initial claim but the latter include returns where no EITC was claimed.

Table 2-9: Tax Year 2014–2016 Individual Income Tax Underreporting Tax Gap with and without Undetected Income: Sources of Income

(Money amounts are in billions of dollars) [1]

Tax Return Income Line Items Grouped by Visibility Category	Estimates *without* Undetected Income: Tax Gap	Estimates *without* Undetected Income: Share of Tax Gap	Estimates *with* Undetected Income: Tax Gap	Estimates *with* Undetected Income: Share of Tax Gap
Total Underreporting Tax Gap	**145**	**100%**	**278**	**100%**
Substantial Information Reporting and Withholding	**3**	**2%**	**7**	**2%**
Wages, salaries, tips	3	2%	7	2%
Substantial Information Reporting	**7**	**5%**	**15**	**5%**
Interest income	*	*	1	*
Dividend income	*	*	1	*
State income tax refunds	*	*	1	*
Pensions & annuities	4	3%	7	2%
Unemployment Compensation	*	*	*	*
Taxable Social Security benefits	2	1%	6	2%
Some Information Reporting	**10**	**7%**	**43**	**15%**
Partnership, S Corp., Estate & Trust, etc.	6	4%	25	9%
Alimony income	*	*	*	*
Capital gains	4	3%	18	6%
Short-term Capital Gains	2	1%	6	2%
Long-term Capital Gains	2	2%	12	4%
Little or No Information Reporting	**50**	**35%**	**126**	**45%**
Form 4797 income	1	1%	4	1%
Other income	7	5%	16	6%
Nonfarm proprietor income	34	24%	80	29%
Farm income	2	1%	5	2%
Rents & royalties	6	4%	21	7%

[1] Estimates reflect an annual weighted average for the associated three-year time period. For the TY 2014–2016 estimate, TY 2016 is only reflected for certain credits and other taxes. All other lines for TY 2014–2016 reflect TY 2014 – 2015.

* Less than $0.5 billion or 0.5 percent

NOTE: Components might not sum to totals because of rounding.

Table 2-10: Tax Year 2014–2016 Individual Income Tax Underreporting Tax Gap with and without Undetected Income: Offsets to Income, Credits, Filing Status, Other Taxes, and Other Unallocated Marginal Effects

(Money amounts are in billions of dollars)[1]

	Estimates *without* Undetected Income		Estimates *with* Undetected Income	
Tax Return Line Items	**Tax Gap**	**Share of Tax Gap**	**Tax Gap**	**Share of Tax Gap**
Total Underreporting Tax Gap	**145**	**100%**	**278**	**100%**
Offsets to Income	**26**	**18%**	**25**	**9%**
Total Statutory Adjustments	-1	-1%	-5	-2%
SE Tax deduction	-2	-1%	-6	-2%
All other adjustments	1	1%	1	*
Deductions	20	14%	22	8%
Exemptions	6	4%	8	3%
Total Credits	**38**	**27%**	**42**	**15%**
Child Tax Credit and Additional Child Tax Credit	8	6%	8	3%
EITC	24	17%	28	10%
Education Credits	5	3%	5	2%
All Other Credits	2	1%	2	1%
Filing Status	**5**	**3%**	**5**	**2%**
Other Taxes	**3**	**2%**	**4**	**1%**
Unallocated Marginal Effects	**3**	**2%**	**11**	**4%**

[1] Estimates reflect an annual weighted average for the associated three-year time period. For the TY 2014–2016 estimate, TY 2016 is only reflected for certain credits and other taxes. All other lines for TY 2014–2016 reflect TY 2014 – 2015.

* Less than $0.5 billion or 0.5 percent

NOTE: Components might not sum to totals because of rounding.

Table 2-11 shows two implicit multipliers that show the overall effect of DCE:

(1) The **NMA Implicit Multiplier** is a ratio defined as the net misreported amount after the imputation of undetected income over the net misreported amount based on amounts detected by examiners.

(2) The **Tax Gap Implicit Multiplier** is a ratio defined for a given item as the tax gap associated with that item calculated based on including imputed undetected income over the tax gap associated with that item calculated based on the amounts as detected by the examiner.

Table 2-7: Tax Year 2014–2016 Individual Income Tax Underreporting Tax Gap: Implicit Multipliers

Tax Return Line Items	NMA Implicit Multiplier	Tax Gap Implicit Multiplier
Total Underreporting Tax Gap	**N/A**	**1.9**
Substantial Information Reporting and Withholding	**2.7**	**2.7**
Wages, salaries, tips	2.7	2.7
Substantial Information Reporting	**1.9**	**2.1**
Interest income	2.1	2.4
Dividend income	1.6	2.2
State income tax refunds	1.3	1.4
Pensions & annuities	1.7	1.8
Unemployment Compensation	1.1	1.2
Taxable Social Security benefits	2.5	2.7
Some Information Reporting	**4.0**	**4.3**
Partnership, S-Corp, Estate & Trust, etc.	3.7	4.2
Alimony income	1.0	1.0
Capital gains	4.4	4.5
Short-term Capital Gains	3.1	4.0
Long-term Capital Gains	2.9	4.8
Little or No Information Reporting	**2.4**	**2.5**
Form 4797 income	3.8	4.9
Other income	1.9	2.4
Nonfarm proprietor income	2.3	2.3
Farm income	2.5	2.6
Rents & royalties	3.1	3.3
Offsets to Income	**0.9**	**1.0**
Total Statutory Adjustments	4.3	4.0
SE Tax deduction	2.6	2.8
All other adjustments	1.0	1.0
Deductions	1.0	1.1
Exemptions	1.0	1.2
Total Credits	**1.1**	**1.1**
Child Tax Credit and Additional Child Tax Credit	0.9	0.9
EITC	1.2	1.2
Education Credits	1.0	1.0
All Other Credits	1.0	1.0
Filing Status	**N/A**	**1.1**
Other Taxes	**1.4**	**1.4**
Unallocated Marginal Effects	**N/A**	**3.2**

Since some taxpayers report negative income and marginal tax rates are progressive, the Tax Gap Implicit Multiplier can exceed the NMA Implicit Multiplier for some line items. The tax calculator does not explicitly calculate tax credits other than the Earned Income Tax Credit, the Child Tax Credit, and the Additional Child Tax Credit. Therefore, the implicit multiplier on Education Credits and Other Credits equals one by design. Similarly, we decided that there were too few observations to imputed undetected alimony income and therefore the implicit multiplier for that item also equals one by design.

Although we are reporting implicit multipliers, the implementation of DCE did not actually use a multiplier approach. The last time a multiplier approach was used was for the TY 2001 tax gap estimates.

2.8.1 Taxable Social Security Benefits

The NMA and tax gap associated with taxable social security benefits were calculated after adding misreported income for the other income items (instead of holding those items fixed at their reported amounts). This method of calculating taxable social security benefits was an improvement over prior tax gap estimates because a portion of underreported taxable social security benefits results from unreported income increasing the taxable portion and not necessarily from the failure to report gross social security benefits. However, this does mean that a portion of the tax gap estimate associated with taxable social security benefits results from increases in the marginal tax rate related to misreporting on multiple line items. In that sense, the marginal tax rates used to calculate the tax gap associated with taxable social security benefits was relatively higher than the marginal rate would have been had all other line items remained at their reported amounts. Although this is inconsistent with the calculation of marginal tax rates on other line items, we deemed it acceptable given the overall improvement in the estimate from explicitly picking up the effects of the misreporting of other line items on the reporting of taxable social security benefits.

2.8.2 Implicit Multipliers Less than One

Implicit multipliers can also be less than one (indicating the estimated tax gap decreased after imputing undetected income) for some offsets to income or tax credits whenever undetected income results in an increase in those amounts. For example, underreported sole proprietor income results in underreporting of the deduction for one-half of self-employment tax. Underreporting of a deduction results in a negative net misreported amount and negative value for the tax gap associated with that underreporting. Although the tax gap associated with total offsets to income is positive, the imputation of undetected income increases the one-half self-employment deduction sufficiently to reduce the overall tax gap associated with offsets to income, resulting in an implicit multiplier of less than one. Similarly, for some credits, imputing undetected income increases taxes which may increase the amount of unused nonrefundable credits that taxpayers are eligible for and could result in an implicit multiplier of less than one.

2.9 References

Kim Bloomquist, Ed Emblom, Drew Johns, and Patrick Langetieg (2012) "Estimates of the Tax Year 2006 Individual Income Tax Underreporting Gap," Paper Presented at the 2012 IRS and the Urban-Brookings Tax Policy Center Research Conference

B. Erard & Associates (2005), "IRS Tax Gap Estimation: Preliminary Results of Detection Controlled Analysis," PowerPoint presentation to Internal Revenue Service Office of Research, November 1, 2005.

B. Erard & Associates (2006), "Preliminary Econometric Results," Results summary report submitted to Internal Revenue Service Office of Research, January 27, 2006.

B. Erard & Associates (2007), "Adjustment of Income Tax Underreporting Using Detection Controlled Estimation," Final Report for IRS Contract Number TIRNO-05-D-00050 0001, November 15, 2007.

B. Erard & Associates (2014), "Econometric Support for Developing DCE Estimates Using NRP Data for TY2006-2008," Final Report for IRS Contract Number TIRNO-10-D-00021-D0003, March 21, 2014.

Brian Erard and Jonathan S. Feinstein (2012), "The Individual Income Reporting Gap: What We See and What We Don't," IRS Research Bulletin, Publication 1500 (Rev. 2012).

Jonathan S. Feinstein (1990), "Detection Controlled Estimation," *Journal of Law and Economics*, 33(1):233-276.

Jonathan S. Feinstein (1991), "An Econometric Analysis of Income Tax Evasion and its Detection," *Rand Journal of Economics*, 22(1):14-35.

Internal Revenue Service (1983), *Income Tax Compliance Research: Estimates for 1973-1981*, *Appendix B.* Department of Treasury.

Internal Revenue Service (1988), *Income Tax Compliance Research: Gross Tax Gap Estimates and Projections for 1973-1992*, IRS Publication 7285 (3-88), Washington, D.C.

Internal Revenue Service (2012), *Tax Gap for Tax Year 2006: Overview.* January 2012.

Internal Revenue Service (2012), *Tax Year 2006 Tax Gap Estimate: Summary of Estimation Methods.* January 2012.

Internal Revenue Service (2016), *Tax Gap Estimates for Tax Years 2008–2010: Overview.* April 2016.

Internal Revenue Service (2019), *Tax Gap Estimates for Tax Years 2011–2013: Overview.* September 2019.

3 Estimates of the Tax Year 2014–2016 Small Corporation Income Tax Underreporting Tax Gap

3.1 Introduction

In estimating the underreporting tax gap for the individual income tax, the Internal Revenue Service (IRS) relies on data from audits of a statistically selected sample of tax returns conducted under the IRS National Research Program (NRP). The IRS does not have a comparable program for all corporations.[13] The absence of comprehensive NRP data for small corporations—those corporations with reported assets of less than $10 million—means that estimating the underreporting tax gap requires the use of operational audit data. Because operational audit cases typically are selected based on characteristics historically associated with a high likelihood of a tax change, it is expected that the average net recommended tax[14] for a group of corporation returns selected for operational audits would exceed the average for a group of corporation returns selected at random. In the statistical and econometric literature, this type of non-representative nature of a sample is referred to as sample selection bias.[15] The former IRS Office of Research contracted with Dr. Brian Erard (B. Erard and Associates)[16] to develop an econometric methodology capable of controlling for selection bias when analyzing operational audit data. The Tax Year (TY) 2014–2016 small corporation income tax underreporting tax gap estimates are based on an implementation of Dr. Erard's methodology.

A microeconometric model was estimated using operational audit data and tax return data for small corporations to develop underreporting tax gap estimates for TY 2014–2016. Operational audit data[17] were combined with a random sample of filed small corporation income tax returns[18] to compute estimates for TY 2014-2016. The estimated average tax gap[19] for TY 2014–2016 is $14 billion, and the average voluntary reporting rate (VRR) is 41 percent.[20] The remainder of this chapter documents the methodology, data, and estimates.

3.2 Methodology and Data

Given a less than one percent annual audit coverage rate for small corporations (Appendix A, Table 3-A3) and variation in examination results from year to year (Appendix A, Table 3-A4), a period estimate can produce more consistent and accurate results than estimating each year separately. Data from TY 2009-2016 were used to jointly estimate the model for the final estimates. Estimates based on alternative combinations of tax years and examination sources are provided in Appendix C.

[13] IRS has a tax year 2010 NRP study of small corporations with a balance sheet reporting assets less than $250,000.
[14] Net recommended tax is the net amount of additional tax recommended by auditors. Net recommended tax is assumed to exclude tax avoided using legally permitted means (e.g. offsetting taxable income with net operating losses).
[15] See Heckman (1979) who developed an econometric technique for controlling for selection bias.
[16] See B. Erard & Associates (2004) for small corporation income tax and B. Erard & Associates (1998) and Eller et al. (2001) for research utilizing a similar methodological approach.
[17] Available through the Audit Information Management System (AIMS) database.
[18] Selected from the Business Returns Transaction File (BRTF) database.
[19] Henceforth, underreporting tax gap and tax gap are used interchangeably.
[20] The VRR is defined as a ratio of the amount of reported tax over the amount of 'true' tax liability for filed returns.

Some examinations are assumed to reflect unique circumstances and are not expected to be representative of a larger segment of the population. Therefore, the final modeling limited the examinations to those examinations expected to be most reflective of the small corporation return population. Although some examinations were excluded from the modelling, the results of those examinations are still included in the tax gap estimates. Essentially those taxpayers are assumed to represent only themselves and do not contribute to predicting the noncompliance of unexamined returns.

Examinations included in the final modeling were those selected based upon their discriminant function (DIF) score, through regular classification, or through statistical sampling.[21] DIF sourced returns, regular classification, and NRP selected returns accounted for roughly half of all small corporation examinations for TYs 2014–2016.

Based on return characteristics from the BRTF data and audit results from the AIMS data, an econometric model estimates five equations jointly:[22]

(1) the probability of a return being audited,
(2) the probability of detecting underreported tax conditional on an audit,
(3) the amount of underreported tax conditional on an audit and detected underreporting,
(4) the probability of detecting overreported tax conditional on an audit,
(5) the amount of overreported tax conditional on an audit and detected overreporting.

The underreporting tax gaps for all examination activity codes[23] were estimated simultaneously. Since there may be return characteristics that are used to select returns for audit that are not observed in the BRTF data, the econometric model allows for correlation in the errors between equations (1) and (2), (1) and (3), and (2) and (3). Although the analysis explored allowing correlations in the error terms, the final models were estimated with correlation coefficients equal to zero[24]. The underlying assumption was that the systematic selection bias could be accounted for through the dependent variables in the model.

Table 3-1 shows a summary of the data used for the final model. The examination results for TYs 2015–2016, as captured by the net recommended tax amounts shown in Table 3-1, are expected to be slightly biased downwards given that seven or eight years of examination closure data are typically required to cover at least 95 percent of the total positive recommended tax for a given tax year (see Appendix B). However, the benefit of including tax return and examination

[21] Examinations used in the modeling included some returns audited through the NRP TY 2010 small corporation reporting compliance study of corporations with a balance sheet and with assets less than $250,000.
[22] See Appendix D for more detail.
[23] Examination activity codes are used for the purpose of allocating examination workload. For corporations, these examination activity codes are based on the level of reported assets.
[24] Correlation coefficients were either not significant or were unstable. In particular, the correlation coefficient between the probability of audit and the probability of a positive recommended tax change conditional on being audited sometimes tended to move towards negative one in the models. When that happened, the model did not appear to converge to an optimum point and the associated tax gap estimates were greatly inflated since the negative correlation coefficient implied that returns that were less likely to be audited were more likely to have a positive recommended tax change.

specific information for TYs 2015–2016 was believed to outweigh the potential downward bias of excluding the two to three percent of examinations yet to close.

Table 3-1 also highlights the economic recovery following the 2008-2009 recession. From TY 2009-2015, reported tax increased by over 42 percent. Furthermore, Table 3-1 underscores the impact of IRS budget cuts (in real dollars and which began with FY 2011) on examination activity. Since TY 2011, the number of audits has decreased both in aggregate numbers and as a share of total returns filed. From TY 2011 to TY 2014, audits declined 35 percent, and total net recommended tax fell 38 percent. It is interesting to note, however, that after TY 2012, average net recommended tax has increased year-on-end, despite years in which total net recommended tax declined.

Table 3-1: Small Corporation Income Tax Underreporting Tax Gap Model: Data Summary

Tax Year	Sample	Number of Audits	Weighted Population	Weighted Reported Tax ($ Millions)	Net Recommended Tax[1] ($ Millions)	Average Net Recommended Tax[1]
2009	71,777	15,997	1,795,633	$7,127	$389	$24,338
2010	62,834	14,668	1,748,158	$7,238	$312	$21,275
2011	64,241	13,299	1,716,421	$7,494	$442	$33,263
2012	50,321	11,395	1,690,204	$8,683	$247	$21,671
2013	48,218	11,106	1,675,174	$8,916	$302	$27,232
2014	40,548	8,678	1,663,203	$9,981	$273	$31,462
2015	32,830	6,768	1,654,270	$10,124	$269	$39,793
2016	31,198	6,691	1,635,517	$9,429	$329	$49,221

[1] Inclusive of all examinations

3.3 Tax Gap Estimates

Table 3-2 shows the final aggregate estimates for the small corporation underreporting tax gap for TY 2014–2016, including the annual average. The final underreporting tax gap estimates were derived by applying the sample-based, estimated VRR to the actual population reported total tax. The estimated average tax gap for TY 2014–2016 is $14 billion, and the average TY 2014–2016 VRR is 41 percent. The low small corporation VRR for tax mirrors the compliance rate observed for sole proprietors, whom one might expect to have similar compliance characteristics as small closely held corporations. As a comparison, the Net Misreporting Percentage (NMP) for nonfarm proprietor income that should have been reported on individual income tax returns by sole proprietors for this period was 57%, suggesting about 43% of nonfarm proprietor income was voluntarily reported.

Table 3-2: Tax Year 2014–2016 Small Corporation Income Tax Underreporting Tax Gap Final Estimates
[$ are in Millions]

Tax Year	VRR: Sample	Population	Reported Tax	Final Tax Gap
2014	44%	1,722,749	$10.2	$13.1
2015	42%	1,711,349	$10.0	$14.0
2016	38%	1,687,265	$9 .4	$15.2
Average	**41%**	**1,707,121**	**$9.9**	**$14.1**

Table 3-3 shows TY 2014–2016 annual average estimates for the small corporation underreporting tax gap by activity code. Unlike the estimates in Table 3-2, these figures are based on the sampled returns weighted to estimate the population instead of applying the estimated VRR to actual population data. The sampled returns used for modeling were limited to returns filed within the first two processing years following the tax year of the return. Conversely, the population totals in Table 3-2 reflect all returns filed through processing year 2021 for each respective tax year. Therefore, the estimate reported in Table 3-3 is slightly different from the final overall estimate reported in Table 3-2.

Table 3-3: Tax Year 2014–2016 Annual Average Small Corporation Income Tax Underreporting Tax Gap Based on Sample, By Activity Code (based on end of year assets)

Activity Code	Assets	Estimated Population Count	Reported Tax ($ Millions)	Tax Gap ($ Millions)	VRR	Average Tax Gap
203	No Balance Sheet	377,119	$513	$3,431	13%	$9,098
209	< $250,000	803,355	$938	$4,543	17%	$5,655
213	< $1,000,000	285,136	$1,654	$2,614	39%	$9,169
215	< $5,000,000	155,881	$3,987	$3,042	57%	$19,513
217	< $10,000,000	29,505	$2,752	$440	86%	$14,927
Total		**1,650,997**	**$9,845**	**$14,071**	**41%**	**$8,522**

3.4 Comparison of Econometric Method to Alternative Methods

Table 3-4 compares tax gap estimates using the econometric method to estimates using two alternative methods. The first alternative method is the average exam adjustment method.
The average exam adjustment method assumes that the observed average examination recommended adjustment amounts reflects the true average underreported amount for the population. This method calculates the average examination recommended adjustment amounts by examination activity code (based on levels of reported assets) and multiplies those amounts by the number of returns in the population in those activity codes.

The second alternative method is the examination VRR method. The examination VRR method assumes that the observed VRR on examinations reflects the true VRR for the population. This method calculates the VRR using examination recommended adjustment amounts and the reported tax of examined corporations. The VRRs are calculated by examination activity code and then applied to total reported tax of the population of returns in the relevant activity code.

The first two columns in Table 3-4 show the outcome of these approaches when the average examination adjustment and VRR were calculated using TY 2014–2016 audit data. Table 3-4 shows that the estimates based on calculating the average examination adjustment amount and then applying that to the population of small corporations results in a much larger estimate than the econometric method (about two and a half times as large). This result is consistent with the presumption that audited small corporations are likely to have much larger underreported tax than unaudited small corporations. It is also evidence that the econometric method controlled for a significant amount of selection bias through the observed dependent variables in the model.

Table 3-4 further shows that the final econometric estimates were a little over twice as large as the examination VRR method. This result suggests that audited small corporations may report a higher percentage of their true tax compared to unaudited small corporations, despite underreporting more tax on average. The possibility that audited returns report a higher percentage of their true tax does not suggest that the examination program is not effective at selecting returns with a higher likelihood of a large tax change. This can be illustrated with a simple example. Suppose corporation A reported $5,000 in tax but should have reported $10,000 and therefore had a VRR of 50 percent. Suppose corporation B reported $30,000 in tax but should have reported $50,000 and therefore had a VRR of 60 percent. While corporation B reported a higher percentage of its tax, it also misreported four times as much tax as the first corporation. An examination program focused on maximizing the amount of revenue from its audits would likely prioritize auditing corporation B.

Table 3-4: Estimated TY 2014-2016 Small Corporation Income Tax Underreporting Tax Gap Using Alternative and Econometric Methods

[Money amounts are in billions of dollars]

	Based on TY 2014–2016 Audits		
Tax Year	**Average Examination Adjustment Method[1]**	**Examination VRR Method[2]**	**Final Econometric Method**
2014	$36.0	$6.7	$13.1
2015	$35.9	$6.5	$14.0
2016	$35.6	$5.9	$15.2
Average	**$35.9**	**$6.4**	**$14.1**

[1] Assumes that the observed average recommended adjustment amount for a given examination activity code (based on level of assets) for operational examinations is the same as the true average for the population.

[2] Assumes that the observed Voluntary Reporting Rate (VRR) within a given examination activity code (based on level of assets) for operational examinations is the same as the true VRR for the population.

3.5 Appendix A: Examination Coverage and Recommended Tax by Activity Code

Table 3-A1: Form 1120 Examinations Closed through December 2021 by Activity Code and Tax Year - Corporations with Assets Less Than $10 Million

Activity Code	Tax Year							
	2009	2010	2011	2012	2013	2014	2015	2016
203	2,180	1,869	1,878	1,560	1,693	1,294	912	928
209	6,588	7,361	6,246	5,434	5,233	3,388	2,460	2,339
213	4,403	3,392	3,328	2,899	2,695	2,767	2,310	2,087
215	2,576	1,931	1,644	1,425	1,293	1,061	864	1,078
217	647	470	443	345	353	331	278	283
Total	16,394	15,023	13,539	11,663	11,267	8,841	6,824	6,715

Table 3-A2: Form 1120 Returns Filed by Activity Code and Tax Year - Corporations with Assets Less Than $10 Million

Activity Code	Tax Year							
	2009	2010	2011	2012	2013	2014	2015	2016
203	411,824	409,347	406,386	385,989	391,496	393,359	400,149	402,108
209	963,858	927,390	900,773	893,756	871,192	848,057	829,025	804,997
213	322,394	311,318	304,088	298,643	295,387	294,122	292,766	290,030
215	159,941	156,857	155,121	154,450	155,684	157,847	159,300	159,360
217	27,334	27,298	27,577	28,005	28,583	29,364	30,109	30,770
Total	1,885,351	1,832,210	1,793,945	1,760,843	1,742,342	1,722,749	1,711,349	1,687,265

Table 3-A3: Form 1120 Examination Coverage Rate* through December 2021 by Activity Code and Tax Year - Corporations with Assets Less Than $10 Million

Activity Code	Tax Year							
	2009	2010	2011	2012	2013	2014	2015	2016
203	0.5%	0.5%	0.5%	0.4%	0.4%	0.3%	0.2%	0.2%
209	0.7%	0.7%	0.7%	0.6%	0.6%	0.4%	0.3%	0.3%
213	1.4%	1.1%	1.1%	1.0%	0.9%	0.9%	0.8%	0.7%
215	1.6%	1.2%	1.1%	0.9%	0.8%	0.7%	0.5%	0.7%
217	2.4%	1.7%	1.6%	1.2%	1.2%	1.0%	0.9%	0.9%
Total	0.9%	0.8%	0.8%	0.7%	0.7%	0.5%	0.4%	0.4%

* This coverage rate reflects audit coverage of filed returns for a given tax year through December 2021. The coverage rates reported in the IRS's Data Books use a different definition of coverage rate.

Table 3-A4: Form 1120 Average Positive Recommended Tax Change by Activity Code and Tax Year - Corporations with Assets Less Than $10 Million

Activity Code	Tax Year							
	2009	2010	2011	2012	2013	2014	2015	2016
203	$19,560	$19,743	$97,971	$19,816	$31,640	$30,816	$34,911	$45,856
209	$15,648	$14,550	$15,677	$21,586	$27,205	$39,484	$32,562	$33,461
213	$21,092	$26,814	$27,496	$22,351	$26,736	$31,605	$37,972	$46,955
215	$35,474	$46,368	$41,110	$25,003	$36,374	$32,351	$91,096	$49,389
217	$150,873	$41,075	$69,932	$74,924	$35,963	$40,344	$33,314	$234,817
Total	$26,147	$22,929	$34,734	$23,543	$29,093	$34,931	$42,112	$50,415

3.6 Appendix B: Timeline of Examination Closing and Recommended Tax

Table 3-B1: Audits of Corporations with Assets Less Than $10 Million – Years of Audit Data Needed to Cover Majority of Closures and Positive Recommended Additional Tax

Tax Year	Years of Data Available	Total Closures			Recommended Additional Tax		
		75%	90%	95%	75%	90%	95%
2006	15	4	5	6	6	7	8
2007	14	4	5	6	5	6	7
2008	13	4	5	6	5	6	7
2009	12	4	5	5	5	8	8
2010	11	4	4	5	4	6	7
2011	10	4	4	5	4	6	7
2012	9	4	4	5	4	6	7
2013	8	4	4	5	5	6	8
2014	7	3	4	5	5	6	6
2015	6	4	4	5	5	5	6
2016	5	3	4	5	5	5	5

3.7 Appendix C: Tax Year 2014–2016 Small Corporation Income Tax Underreporting Tax Gap Estimates Under Different Estimation Scenarios

Table 3-C1 presents a sensitivity analysis of the impact of alternative combinations of tax years and mix of examinations (including or not including TY 2010 NRP examinations) on the tax gap estimate. Notably, including TYs 2009–2012 appears to raise the estimate. Including the TY 2010 NRP returns lowers the estimate relative to not including them. And, finally, including TY 2013 decreases the estimate relative to only including TY 2014–2016 in the estimation.

Table 3-C1: Tax Year 2014–2016 Small Corporation Income Tax Underreporting Tax Gap Estimates Under Different Estimation Scenarios ($ in Billions)

		TY 2014 - 2016 Average		
Tax Years Used in Estimation	**Inclusion of TY 2010 NRP Examinations**	**Reported Tax**	**Tax Gap**	**VRR**
2009 - 2016	Included	$9.9	$14.1	41.2%
2009 - 2016	Not Included	$9.9	$18.4	34.8%
2014 - 2016	Not Included	$9.9	$13.0	43.1%
2013 - 2016	Not Included	$9.9	$12.6	43.3%

3.8 Appendix D: Model Specification

3.8.1 Underreported Tax

The implemented methodology for estimating underreported tax was derived from Erard (1998 and 2004) and consists of estimating three equations jointly: the probability of audit, the probability of underreported tax conditional on an audit, and the amount of underreported tax conditional on a positive recommendation.

3.8.1.1 Probability of Audit

The probability of audit was modeled using a probit specification:

$$[1] \qquad A^* = \beta_A' x_A + \varepsilon_A$$

In equation [1], A^* is a latent variable representing the index of the likelihood that a return will be audited, x_A, is a vector of return characteristics, β_A' is a vector of coefficients to be estimated, and ε_A is a standard normal random disturbance. In the data we do not observe A^*, instead we observe A which is conditional on A^*:

$$A = \begin{cases} 1\,(\text{Audit}) & A^* > 0 \\ 0\,(\text{No audit}) & \text{otherwise} \end{cases}$$

3.8.1.2 Probability of Detected Underreporting

The probability of positive tax change conditional on an audit taking place was also modeled using a probit specification:

$$[2] \qquad P^* = \beta_P' x_P + \varepsilon_P$$

In equation [2], P^* is a latent variable representing the index of the likelihood of a positive tax change, x_P is a vector of return characteristics, β_P' is a vector of coefficients to be estimated, and ε_P is a standard normal random disturbance. In the data we do not observe P^*, instead we observe P which is conditional on A^* and P^*:

$$P = \begin{cases} 1\,(\text{Positive tax change recommended}) & A^* > 0 \text{ and } P^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

3.8.1.3 Log of Positive Tax Change

The amount of underreported tax conditional on an audit taking place and the recommended tax change being positive was modeled using a log-normal specification:

$$[3] \qquad ln(R) = \beta_R' x_R + \varepsilon_R$$

In equation [3], $ln(R)$ represents the natural log of the positive tax change, x_R, is a vector of return characteristics, β'_R is a vector of coefficients to be estimated, and ε_R is a normally distributed random disturbance. We observe R in the data but it is conditional on A^* and P^*:

$$R = \begin{cases} R\ (\text{Amount of positive tax change}) & A^* > 0 \text{ and } P^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

3.8.1.4 Restricted Correlations

The model partially controls for selection bias by conditioning on observed return information and compliance risk measures. However, if there is information that we do not observe in the data (e.g. an audit selection filter) that increases the likelihood of a return being selected for audit, that same unobserved information may also be correlated with the likelihood of the audit resulting in a positive recommended tax adjustment. If this correlation exists, the model may overestimate the amount of noncompliance associated with the unaudited returns. To further control for selection bias, the model allows for free correlations (ρ_{AP}, ρ_{AR}, ρ_{PR}) among ε_A, ε_P, and ε_R. These correlations allow for the possibility that unobserved information about the audit selection process may also affect the likelihood or amount of underreported tax. However, in practice, the estimated correlation coefficients ρ_{AR}, ρ_{PR} were typically statistically insignificant from zero. The correlation coefficient ρ_{AP} was often unstable, sometimes tending towards negative one. That negative correlation coefficient suggested that unaudited returns were much more likely to have a positive recommended tax change and generated highly unstable estimates that were implausibly large. Therefore, the final models were estimated with all correlation coefficients constrained to zero. Given the instability in the correlation coefficients, constraining the correlation coefficients to zero actually resulted in lower estimates than had the model allowed for free correlations.

3.8.2 Overreported Tax

The implemented methodology also estimated the amount of overreported tax by jointly estimating the probability of overreported tax conditional on being audited and the amount of overreported tax conditional on overreported tax being present. The model assumed that there was no correlation in unobserved determinants of the likelihood of being audited and determinants of the probability of overreported tax and amount of overreported tax. Likewise, the model assumed there was no correlation between unobserved determinants of the probability of overreported tax and the amount of overreported tax.

3.8.2.1 Probability of Overreported Tax

The probability of a negative tax change conditional on an audit taking place was modeled using a probit specification:

$$[4] \qquad Q^* = \beta'_Q x_Q + \varepsilon_Q$$

In equation [4], Q^* is a latent variable representing the index of the likelihood of a negative tax change, x_Q is a vector of return characteristics, β'_Q is a vector of coefficients to be estimated, and

ε_Q is a standard normal random disturbance. In the data we do not observe Q*, instead we observe Q which is conditional on A* and Q*:

$$Q = \begin{cases} 1 \left(\text{Negative tax change recommended}\right) & A^* > 0 \text{ and } Q^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

3.8.2.2 Log of Negative Tax Change

The amount of overreported tax conditional on an audit taking place and the recommended tax change being negative was modeled using a log-normal specification:

$$[5] \qquad \ln(M) = \beta'_M x_M + \varepsilon_M$$

In equation [5], $\ln(M)$ represents the natural log of the negative tax change, $x_{M,}$ is a vector of return characteristics, β'_M is a vector of coefficients to be estimated, and ε_M is a normally distributed random disturbance. We observe M in the data, but it is conditional on A* and Q*:

$$M = \begin{cases} M \left(\text{Amount of negative tax change }\right) & A^* > 0 \text{ and } Q^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

3.9 References – Chapter 2

B. Erard & Associates (1998), "Estate Tax Underreporting Gap Study: A Report Prepared for the Internal Revenue Service Economic Analysis and Modeling Group" Draft Report for IRS Contract TIRNO-98-P-00406, November,5, 1998.

B. Erard & Associates (2004), "Development of a Strategy for Estimating the Federal Income Tax Reporting Gap Among Small Corporations," Draft Report for IRS Contract TIRNO-03-P-00429, July 16.

Eller, Martha Britton, Brian Erard and Chih-Chin Ho (2001), "Noncompliance with the Federal Estate Tax." Rethinking Estate and Gift Taxation, ed. Gale, William G., James R. Hines Jr. and Joel Slemrod. Brookings Institution Press. Washington, D.C., pp. 375- 421, 2001.

Heckman, J (1979), 'Sample selection bias as a specification error', *Econometrica*, vol. 47, no. 1, pp. 153–61.

4 Estimates of the Tax Year 2014–2016 Large Corporation Income Tax Underreporting Tax Gap

4.1 Introduction

This chapter presents the methodology and data used to estimate the income tax underreporting tax gap for large corporations—corporations with reported assets of $10 million or more. [25] The methodology depends heavily on analysis of the "largest corporations", defined as those with reported assets of $250 million or more. These corporations represent only about 0.5 percent of all corporations and about 16 percent of all large corporations, but account for the vast majority of reported corporation income tax and audit recommended tax adjustments. Table 4-1 displays the population counts and total reported tax for large corporations for Tax Years (TYs) 2002–2016. During this period the 7,000 largest corporations accounted for over 90 percent of total tax reported by large corporations. Table 4-2 shows the number of audited corporations and net additional recommended tax by asset size category.[26] From TY 2002–2011, the largest corporations, on average, also accounted for around 95 percent of the net additional recommended tax by IRS examiners.

Table 4-1: Number of Large Corporation Income Tax Returns and Total Tax Reported by Asset Size-Tax Years 2002–2016

[Money amounts are in millions of dollars]

	All Large Corporations		Asset Size Category				
	$10M and Over		$10M to $250M		$250M and Over		
Tax Year	Number of Returns	Reported Tax	Number of Returns	Reported Tax	Number of Returns	Reported Tax	Share of Reported Tax
2002	44,268	$144,895	37,653	$14,730	6,615	$130,165	90%
2003	44,943	$166,511	38,135	$15,389	6,808	$151,122	91%
2004	45,892	$211,239	38,779	$18,475	7,113	$192,764	91%
2005	47,397	$293,540	40,003	$22,922	7,394	$270,618	92%
2006	48,814	$319,895	41,102	$24,763	7,712	$295,132	92%
2007	49,423	$295,341	41,575	$22,853	7,848	$272,488	92%
2008	47,340	$219,856	39,621	$17,370	7,719	$202,486	92%
2009	45,415	$184,270	37,698	$16,267	7,717	$168,003	91%
2010	46,231	$206,650	38,391	$17,616	7,840	$189,034	91%
2011	47,252	$215,022	39,260	$18,401	7,992	$196,622	91%
2012	48,151	$251,097	40,022	$20,522	8,129	$230,575	92%
2013	49,752	$277,417	41,455	$21,171	8,297	$256,246	92%
2014	51,417	$314,906	42,792	$22,276	8,625	$292,630	93%
2015	52,789	$311,871	43,949	$21,355	8,840	$290,516	93%
2016	54,168	$294,571	45,209	$21,148	8,959	$273,423	93%

[25] The large corporation taxpaying population is limited to Form 1120 and Form 1120A filers.

[26] Unless otherwise noted, the number of audits, recommended tax, and coverage rates in this chapter exclude audits opened due to the filing of claims for refund/abatement, such as audits directly related to net operating loss (NOL) carryback claims. Note, however, that returns selected for examination for reasons unrelated to claims for refund/abatement may result in adjustments to NOLs, credits, losses, etc. that lead to a negative tax change and subsequent refund.

Table 4-2: Number of Audited Large Corporation Income Tax Returns and Net Recommended Additional Tax by Asset Size – Tax Years 2002–2011

	All Large Corporations		Asset Size Category				
	$10M and Over		$10M to $250M		$250M and Over		
Tax Year	N	Tax	N	Tax	N	Tax	Share of Net Recommended Additional Tax
2002	4,803	$12,985	3,257	$514	1,546	$12,471	96%
2003	6,683	$16,342	4,785	$388	1,898	$15,954	98%
2004	8,154	$16,499	6,081	$726	2,073	$15,773	96%
2005	7,287	$19,246	5,173	$612	2,114	$18,634	97%
2006	7,497	$15,640	5,107	$695	2,390	$14,945	96%
2007	8,367	$13,035	6,047	$632	2,320	$12,403	95%
2008	9,008	$13,106	6,407	$1,030	2,601	$12,076	92%
2009	7,679	$8,614	4,934	$446	2,745	$8,168	95%
2010	6,081	$10,501	3,739	$613	2,342	$9,888	94%
2011	5,458	$7,717	3,368	$648	2,090	$7,069	92%

Source: Compiled from the CDW Audit Information Management System (AIMS) Database

* Audits opened to examine refund claims (e.g. carryback/carryover claims) are not included.

In contrast to the estimation approach used for the individual income tax underreporting tax gap which relies on IRS National Research Program (NRP) audit data, IRS estimates of the income tax underreporting tax gap for large corporations relies on data from operational tax audits. Mainly, this is due to the difficulty of constructing a representative sample for this small group of highly diverse corporations.

As discussed previously, because operational audit returns typically are selected based on characteristics historically associated with a high likelihood of a tax change[27], it is expected that the average net recommended tax[28] for a group of returns selected for operational audits would exceed the average for a group of returns selected at random. Although econometric techniques to correct for sample selection bias have been developed (see Heckman 1979), the small number of audited corporations and the high degree of heterogeneity among large corporations make the application of these methods impractical.

[27] This is especially true for corporations with total assets between $10-$under $250 million. The probability of audit for these taxpayers averaged 12 percent over the period TY 2002–2011. In contrast, the largest corporate taxpayers (those with assets of $250 million and higher) faced a much higher probability of audit, averaging 29 percent over the same period. A significant number of these very large taxpayers are a part of the IRS's Large Corporate Compliance (LCC) Program (formerly the Coordinated Industry Case (CIC) program) which places many of these firms under continuous or frequent audit.

[28] Net recommended tax is the net amount of additional tax recommended by auditors. Net recommended tax is assumed to exclude tax avoided using legally permitted means (e.g. offsetting taxable income with net operating losses).

This chapter describes an approach the IRS has developed for estimating income tax underreporting for the largest corporations using data from operational audits. The methodology relies on a fundamental theorem of extreme value theory, which holds that the largest observations of a stochastic process are Pareto-Zipf distributed. By making this assumption (which is supported by theoretical and empirical research as described in the following section) one can derive an estimate of total tax underreporting for all corporations with $250 million or more in assets using audit results only for the very largest cases. [29] The theoretical and empirical basis for the methodology is presented in the next section followed by a discussion of data sources and data transformation procedures described in section three. The fourth section demonstrates the approach using operational audit data. Finally, the results are compared to estimates based on simple ratios and evaluated.

4.2 Theoretical and Empirical Foundation

A variety of natural phenomena have measures of size or scale that vary over an enormous range and where most observations are small in size and a few are very large. Some examples include city populations and earthquake magnitudes (Newman 2005). Such distributions are known as *power law* distributions and take the following form

$$[1] \quad p(x) = Cx^{-\alpha} \qquad \text{where } \alpha > 1$$

In equation [1] $p(x)$ is the probability density function (PDF) of observations with size x, $C = e^c$, and α and c are constants. An interesting feature of such distributions is that a plot of the frequency of observations against a measure of size using a log-log transformation results in a distribution that resembles a straight line.

$$[2] \quad \ln p(x) = -\alpha \ln x + c$$

The *Pareto* distribution is a special class of power law distributions. The Pareto distribution is defined using the cumulative distribution function (CDF); i.e. the probability of observing a realization of X greater than x is an inverse power of x:

$$[3] \quad P[X > x] \sim x^{-k}$$

In expression [3] the exponent k is the Pareto shape parameter and is equivalent to the exponent of the power law distribution $\alpha - 1$ (Adamic 2000).

The Pareto distribution (Pareto 1898) is best known among economists as an empirical distribution of income. Interest in the study of income distributions and other economic phenomena exhibiting similar "power law"-like properties has exploded in recent years. Research in this area, once largely relegated to the econophysics literature, has gone mainstream (Gabaix 2016). Across studies, scholars have found a similar pattern wherein the income and wealth of individuals displays a two-class distribution in which the top 1-3 percent of the population is characterized by

[29] The methodology and approach to estimating total tax underreporting for large corporations with total assets between $10 million and $250 million is discussed in section 4.5.

a Pareto distribution (this is referred to as having a Pareto tail) and the remaining majority is described by either an exponential or log-normal distribution (Chatterjee, Yarlagadda, and Chakrabarti 2005).

The leading theory as to why Pareto distributions occur, revolves around the idea that Pareto distributions result from a dynamic, proportional, "random growth" process. One of the earliest proponents of this hypothesis was Mandelbrot (1960), who found that Pareto tails could be generated by a stochastic process known as a Levy random walk (Levy and Solomon 1997).

A competing, yet related hypothesis for explaining the formation of Pareto tails involves the concept of "transference of power laws". The idea here is that a pareto distribution emerges because of some other variable having a Pareto distribution. This assertion is at the heart of what is called the "economics of superstars" and the notion of "span of control" associated with hierarchical organizations (Simon 1957, Lydall 1959, Rosen 1981). This view is supported in a paper by Gabaix and Landier (2008), who find the growth in CEO compensation among S&P 500 corporations between 1980 and 2003 is driven by the average rate of growth in market capitalization, which, itself, is pareto distributed. Although this chapter focuses on corporations and not individuals located within these corporations, by extension the argument could be made that CEO compensation reflects the span of control of the firm the CEO heads.

In addition to being characteristic of the upper tail of income and wealth distributions, the generalized Pareto distribution also is the limiting distribution for observations in the tail region of a random variable. This is a fundamental theorem in a branch of statistics known as Extreme Value (EV) theory. There is a vast literature on the use of the generalized Pareto distribution by the insurance industry to model extreme loss events (Embrechts, Klüppelberg, and Mikosch 1999, Beirlant, et al. 2004, Henry and Hsieh 2009).

Closely related to the Pareto distribution is the Zipf distribution. However, rather than looking at the frequency distribution of a random variable, the Zipf distribution is produced by ranking the observations. The Zipf distribution (Zipf 1949) can be obtained from the Pareto distribution by an exchange of variables. Adamic (2000) explains this relationship as follows[30]:

> "The phrase 'The *r*th largest firm has *n* employees' is equivalent to saying '*r* firms have *n* or more employees'. This is exactly the definition of the Pareto distribution, except the x and y axes are flipped. Whereas for Zipf, *r* is on the x-axis and *n* is on the y-axis, for Pareto, *r* is on the y-axis and *n* is on the x-axis. Simply inverting the axes, we get that if the rank exponent is *b*, i.e., $n \sim r^{-b}$ in Zipf, then the Pareto exponent is $1/b$ so that $r \sim n^{-1/b}$."

The Pareto-Zipf distribution, importantly, can also be found in relation to firm characteristics. A study by Axtell (2001) finds that the distribution of U.S. firm sizes, using both the number of employees and gross receipts as measures of firm size, follows a Pareto-Zipf distribution. Other studies, including Fujiwara et al. (2004), Di Giovanni et al. (2011), and Hamilton (2012), have confirmed this relationship. In all of these studies the strongest case for a Pareto-Zipf distribution is found among observations in the upper tail (i.e., the largest corporations). Based on these studies,

[30] Adamic (2000) uses the distribution of city populations to illustrate the relationship between the Zipf distribution and the Pareto distribution. In this citation we have substituted the words "employees" and "firm" for "inhabitants" and "city".

our findings that the upper tail of firm incomes (and tax liabilities) is Pareto distributed, fits well with the literature.

The methodology presented in the following section uses the Zipf distribution to estimate corporation income tax underreporting. However, as indicated by the above discussion, the Zipf and Pareto distributions are mathematically interchangeable[31].

4.3 Data

The timing of operational audit data is an important consideration. Operational audits of large corporations can take years to complete. The final results of such audits are not reflected in IRS data until many years following the year the return was filed. Table 4-3 displays the number of years necessary to accumulate the majority of audit closures and recommended additional tax for each tax year from 2002 to 2016.[32] The bottom row of Table 4-3 shows that for TY 2002 to TY 2008, it took an average of 10 years to accumulate 95 percent of audit closures and an average of 13.4 years to accumulate 95 percent of the total recommended additional tax. Based on this observation we limit our analysis to data for tax years 2005 to 2011 and earlier, reflecting tax years with at least 10 years of audit data[33]. In the next section we describe the method to develop tax gap estimates using the results from those tax years.

Table 4-3: Audits of Corporations with Assets of $250 Million or More: Years of Audit Data Needed to Cover Majority of Closures and Recommended Additional Tax

Tax Year	Years of Data Available	Total Closures			Recommended Additional Tax		
		75%	90%	95%	75%	90%	95%
2002	19	6	9	11	9	13	14
2003	18	6	9	10	11	13	15
2004	17	6	9	10	11	13	14
2005	16	6	9	10	10	12	14
2006	15	6	8	10	11	12	13
2007	14	6	8	10	10	12	13
2008	13	5	7	9	9	9	11
2009	12	5	7	8	8	10	11
2010	11	5	7	8	8	8	9
2011	10	5	7	8	6	9	9
2012	9	5	7	8	6	6	9
2013	8	5	6	7	8	9	9
2014	7	5	6	7	7	7	8
2015	6	5	5	6	6	6	6
2016	5	4	5	5	5	5	5
2002 - 2008 Average		5.9	8.4	10.0	10.1	12.0	13.4

[31] Also see Newman (2005) for an example illustrating the theoretical equivalence between the Zipf and Pareto distributions.

[32] The number of years necessary is calculated as the calendar year when a given closure level was attained minus the tax year.

[33] The TY 2011 – 2013 large corporation income tax underreporting tax gap estimates were based on audit data from TY 2002 to 2008. Therefore, the use of TY 2005 to 2011 to estimate the TY 2014 – TY 2016 large corporation income tax underreporting tax gap reflects a consistent three-year shift in the data.

4.4 Data Transformation and Estimation

The first step in estimation is a transformation of net tax recommended from operational audits.[34] The goal of data transformation is to preserve total net recommended tax change but limit the number of observations to those in the upper tail. To achieve this result, the following sequence of steps is taken:

1. For all operational audit cases (S) in a tax year, sum the net recommended tax change for cases with a refund amount (i.e., negative net tax change). Record this amount as R.
2. Delete all audit cases from S having a refund amount or no tax change.
3. Sort the remaining cases (i.e., those with a positive net recommended tax change) in ascending order by tax change amount.
4. Compute a cumulative sum for tax change.
5. Identify the audit case number (m) where the cumulative sum of tax change is equal to or greater than the total refund amount (R).
6. Delete all cases up to case m - 1. Let N represent the number of remaining audit cases. The sum of recommended tax change for these N corporations is approximately equal to net recommended tax change for all S operational audit cases.
7. Let $p = N / S$ = the proportion of cases remaining after steps 1 to 6.

To perform the estimation, sort the N remaining observations in descending order and rank the observations from 1 to N assigning a value of 1 to the firm with the largest tax change amount. Use OLS regression to obtain an estimate of the slope and y-intercept where the dependent variable is log of recommended tax change and the independent variable is log rank.[35] Table 3-4 shows the estimated OLS coefficients and R-square values using data for TYs 2005–2011.

[34] The source of data for operational audits is the IRS's Audit Information Management System (AIMS).

[35] We use log base 10 for the regressions although one often sees natural logs used in the literature. Another technique described in Gabaix and Ibragimov (2011) is to perform OLS estimation using Rank - ½. This was done for this study and the results were very close with the exception in some years of the amount estimated for the observation with Rank=1. Therefore, the decision was made to use the regression results using the conventional approach described here.

Table 4-4: OLS Regression Results – Corporation Income Tax Returns with Assets of $250 Million or More

Tax Year	N	Intercept	Slope	Adjusted R-Squared
2005	102	9.44703	-0.84528	0.904948
		(0.04463)	(0.02724)	
2006	59	9.29936	-0.74641	0.962371
		(0.02737)	(0.01937)	
2007	59	9.18677	-0.71323	0.953888
		(0.02907)	(0.02058)	
2008	72	9.3444	-0.91816	0.986286
		(0.0192)	(0.01285)	
2009	40	9.20537	-0.86717	0.932553
		(0.04682)	(0.03731)	
2010	66	9.34954	-0.98668	0.967995
		(0.03245)	(0.02225)	
2011	41	9.22338	-1.00881	0.978081
		(0.0302)	(0.02387)	

Note: Standard errors in parentheses.

The next step is to estimate total underreported tax for year t (U_t). We assume that if all the largest corporations were subject to an operational audit and the results transformed as described above, the number of corporations remaining (M) would be equal to p times the total number of very large corporations in the population (F). To derive an estimate of total underreporting for all very large corporations (audited and unaudited) use the slope (a) and intercept (c) values from Table 4-4 and equation [4] below.

$$[4]\quad U_t = 10^c \sum_{r=1}^{M} r^a$$

Table 4-5 displays the estimation results for TYs 2005 to 2011. The total estimated underreported tax for the largest corporations range from a high of $28.4 billion in TY 2005 to a low of $9.2 billion in TY 2011. The voluntary reporting rate (VRR) is also shown for each year. The VRR is calculated as the ratio of reported tax divided by total tax that should have been reported. [36] As the data in Table 4-5 show, the estimated VRR is quite sensitive to the amount of tax reported in a given year. For example, in TY 2009, the estimated underreported tax is $11.5 billion and the corresponding VRR is 93.6 percent. For the following year, TY 2010, the estimated underreported tax grew 20 percent, to $13.8 billion, but the VRR stays almost the same at 93.2 percent. This result is due to the increase in tax reported — a 12.5 percent increase — by corporations in TY 2010 compared to TY 2009. Also notice that from TY 2010 to TY 2011 reported tax increased, while estimated underreported tax decreased, leading to a high VRR for the year. A larger reported total tax does not guarantee a parallel increase in the underreported tax amount.

[36] The total tax that should have been reported is the sum of total reported tax and estimated underreported tax.

Table 4-5: Estimation Results – Corporation Income Tax Returns with Assets of $250 Million or More

[Money amounts are in millions of dollars]

	Tax Year						
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Total Audits (*S*)	2,119	2,399	2,327	2,601	2,745	2,343	2,091
Audits After Transformation (*N*)	102	59	59	72	40	66	41
Ratio of Transformed to Total (*p*)	0.048	0.025	0.025	0.028	0.015	0.028	0.020
Population (*F*)	7,394	7,712	7,848	7,719	7,717	7,840	7,992
Population After Transformation (*M*)	356	190	199	214	112	221	157
Estimated Underreported Tax (*U*)	$28.4	$23.0	$20.0	$16.2	$11.5	$13.8	$9.2
Total Tax Reported	$270.6	$295.1	$272.5	$202.5	$168.0	$189.0	$196.6
Voluntary Reporting Rate (VRR)	90.5%	92.8%	93.2%	92.6%	93.6%	93.2%	95.5%

Given the volatility in the VRR, the average estimated VRR for the period TY 2005-2011 is used to project the tax gap to years TYs 2012 to 2016. The average estimated VRR for TYs 2005 to TY 2011 is 93.1 percent. Under this method of estimating the tax gap, the VRR is assumed to be fixed and an increase (decrease) in reported tax is associated with an increase (decrease) in underreported tax. Table 4-6 presents the results of the tax gap estimation. As Table 4-6 shows, the estimated income tax underreporting tax gap for corporations with assets of $250 million or more peaks at $28 billion in TY 2005 and then falls to $9 billion in TY 2011 but is followed by a rebound in subsequent tax years.

Table 4-6: Estimated Underreported Tax for Corporation Income Tax Returns with Assets of $250 Million or More

[Money amounts are in millions of dollars]

Tax Year	Reported Tax	VRR	Tax Gap
2005	$270.6	90.5%	$28.4
2006	$295.1	92.8%	$23.0
2007	$272.5	93.2%	$20.0
2008	$202.5	92.6%	$16.2
2009	$168.0	93.6%	$11.5
2010	$189.0	93.2%	$13.8
2011	$196.6	95.5%	$9.2
2012	$230.6	93.1%	$17.2
2013	$256.2	93.1%	$19.1
2014	$292.6	93.1%	$21.8
2015	$290.5	93.1%	$21.7
2016	$273.4	93.1%	$20.4

4.5 Tax Gap Estimates for Corporation Income Tax Returns with Assets of $10 Million or More

Table 4-7 displays the estimated income tax underreporting tax gap for corporations with assets of $10 million to $250 million for TYs 2005–2016. The estimated tax gap for these taxpayers assumes identical reporting behavior as that behavior estimated for corporations with assets of $250 million and over. For example, the 2014 tax gap for corporations with $10 to $250 million in assets is calculated as (($22.3 billion / 0.931) - $22.3 billion) = $1.7 billion. The right-most column of Table 4-7 displays the total estimated tax gap for corporations with $10 million or more in assets.

Table 4-7: Estimated Tax Gap for Corporation Income Tax Returns with $10 Million or More in Assets: Tax Years 2005-2016

[Money amounts are in billions of dollars]

	Asset Size Category								
	$250 Million and Over				$ 10 to 250 Million				
Tax Year	N	Reported Tax	Tax Gap	VRR	N	Reported Tax	Tax Gap	VRR	Total Estimated Tax Gap
2005	7,394	$270.6	$28.4	90.5%	40,003	$22.9	$2.4	90.5%	$30.8
2006	7,712	$295.1	$23.0	92.8%	41,102	$24.8	$1.9	92.8%	$24.9
2007	7,848	$272.5	$20.0	93.2%	41,575	$22.9	$1.7	93.2%	$21.6
2008	7,719	$202.5	$16.2	92.6%	39,621	$17.4	$1.4	92.6%	$17.5
2009	7,717	$168.0	$11.5	93.6%	37,698	$16.3	$1.1	93.6%	$12.6
2010	7,840	$189.0	$13.8	93.2%	38,391	$17.6	$1.3	93.2%	$15.1
2011	7,992	$196.6	$9.2	95.5%	39,260	$18.4	$0.9	95.5%	$10.1
2012	8,129	$230.6	$17.2	93.1%	40,022	$20.5	$1.5	93.1%	$18.7
2013	8,297	$256.2	$19.1	93.1%	41,455	$21.2	$1.6	93.1%	$20.7
2014	8,625	$292.6	$21.8	93.1%	42,792	$22.3	$1.7	93.1%	$23.5
2015	8,840	$290.5	$21.7	93.1%	43,949	$21.4	$1.6	93.1%	$23.3
2016	8,959	$273.4	$20.4	93.1%	45,209	$21.1	$1.6	93.1%	$22.0
2014-2016	8,808	$285.5	$21.3	93.1%	43,983	$21.6	$1.6	93.1%	$22.9

Source: Filed return counts and reported tax come from the IRS' Compliance Data Warehouse (CDW) BRTF Form 1120 Database. *Estimated tax gap for corporations with assets between $10 million and $250 million assumes the same reporting compliance behavior as for corporations with assets of $250 million and over.

4.6 Comparison of Extreme Value Method to Alternative Methods

Table 4-8 compares tax gap estimates using the EV method to estimates using the two alternative methods discussed in the small corporation estimation chapter. The first method, the average examination adjustment method, assumes that the observed average examination recommended adjustment amounts reflects the true average underreported amount for the population. This method calculates the average examination recommended adjustment amounts by examination activity code (based on levels of reported assets) and multiplies those amounts by the number of returns in the population in those codes. For TYs 2012–2016, this method yields average estimated VRRs based on the TY 2005–2011 average examination adjustment method and applies those VRRs to the total reported tax each respective tax year. This estimation method for TYs 2012–2016 is equivalent to the method used to for the EV estimates for TY 2012–2016.

The second method, the examination VRR method, assumes that the observed VRR from examinations reflects the true VRR for the population. This method calculates the VRR using examination recommended adjustment amounts and the reported tax of examined corporations. The VRRs are calculated by examination activity code and then applied to total reported tax for the population of returns in the relevant activity code. The TY 2012–2016 estimates are then determined under the assumption of a constant VRR, similar to the average examination adjustment method and EV methods.

As Table 4-8 shows, the examination VRR method tracks closely to the extreme value method, with the former method producing slightly higher estimates for the majority of tax years examined. The TY 2014–2016 EV method underreporting tax gap estimates for large corporations is $23 billion. The examination VRR method underreporting tax gap estimate for TY 2014–2016 is $25 billion. This small difference is to be expected, as the Exam VRR method assumes all corporations (within a given activity code) have the same average yield per dollar of reported income under audit. The average examination adjustment method results in estimates that exceed the examination VRR and EV methods. The average examination adjustment method underreporting tax gap estimate for TY 2014–2016 is $32 billion. This result is expected since the average examination adjustment method does not control for statistical selection bias at all, as the method does not take into account any differences in total tax liability across returns. [37]

Therefore, assuming the IRS selects corporation income tax returns for audit based on the likelihood of noncompliance, we would expect the true average examination adjustment amount for the population to be less than the average examination adjustment amount observed on actual examinations.[38] However, the effect of selection bias on the observed examination VRR is more ambiguous. Corporations with large amounts of underreported tax may not necessarily also have a low voluntary reporting rate, due to these firms' having large reported total tax liabilities. These corporations could potentially have a low net misreporting percentage despite a relatively large dollar amount of tax underreported. Therefore, the true population VRR may be higher or lower

[37] Selection bias in this context means that we expect that returns are selected for examination based on the likelihood of underreported tax and therefore the compliance of examined corporation returns may not be representative of compliance for the overall population.

[38] The premise that the true average underreported amount for the population is less than the observed examination recommended adjustment amount is conditional on the assumption that examination detects all underreporting during the examination.

than the observed examination VRR depending on the relative size of underreported tax and total reported tax.

For TY 2005–2016, the largest of all the large corporations, on average, reported over 92 percent of total tax of all large corporations and accounted for over 94 percent of the net additional tax recommended by IRS examiners. Given this concentration amongst the largest corporations and the high coverage rate of those corporations, the closeness between the examination VRR method and the EV method (which models the "largest of the large" corporations) seems very reasonable.

Table 4-8: Estimated Corporation Income Tax Underreporting Tax Gap Using Alternative and Extreme Value Methods - Corporations with $10 Million or More in Assets

[Money amounts are in billions of dollars]

Tax Year	Average Examination Adjustment Method[1]	Exam VRR Method[2]	Extreme Value Method
2005	$38.8	$30.0	$30.8
2006	$31.4	$23.7	$24.9
2007	$26.6	$19.9	$21.6
2008	$26.7	$20.1	$17.5
2009	$16.8	$13.9	$12.6
2010	$27.0	$19.7	$15.1
2011	$19.4	$14.6	$10.1
2012	$28.9	$20.4	$18.7
2013	$29.6	$22.5	$20.7
2014	$30.8	$25.5	$23.5
2015	$32.0	$25.3	$23.3
2016	$32.8	$24.0	$22.0
2014-2016	$31.9	$24.9	$22.9

[1] Assumes that the observed average recommended adjustment amount for a given examination activity code (based on level of assets) is the same as the true average for the population. TY 2012-2016 are estimates assuming a constant overall VRR equal to the average estimated overall VRR for TY 2005-2011.

[2] Assumes that the observed Voluntary Reporting Rate (VRR) within a given examination activity code (based on level of assets) for operational examinations is the same as the true VRR for the population. TY 2012-2016 are estimates assuming a constant overall VRR equal to the average estimated overall VRR for TY 2005-2011.

4.7 References – Chapter 3

Adamic, L. A., (2000), 'Zipf, power-laws, and pareto – a ranking tutorial', Information Dynamics Lab, HP Labs, working paper.
https://www.hpl.hp.com/research/idl/papers/ranking/ranking.html

Axtell, R. L., (2001), 'Zipf distribution of U.S. firm sizes', *Science*, vol. 293, pp.1818-1820.

Beirlant, J., Goegebeur, Y., Segers, J. and Teugels, J. (2004), *Statistics of Extremes: Theory and Applications*, Hoboken, NJ: Wiley.

Black, T., Langetieg, P., Leibel, K., Payne, M., Johns, A., Plumley A., Risler, M., and Spitzer, E., (2019), Federal Tax Compliance Research: Tax Gap Estimates for Tax Years 2011-2013. IRS Research, Applied Analytics & Statistics. Publication 1415 (Rev. 9-2019).
https://www.irs.gov/pub/irs-pdf/p1415.pdf.

Chatterjee, A., S. Yarlagadda, and B. K. Chakrabarti (eds) (2005), *Econophysics of Wealth Distributions*, Springer, Milan, Italy.

Clementi, F. and Gallegati, M. (2005), 'Pareto's law of income distribution: evidence for Germany, the United Kingdom, and the United States', in A. Chatterjee et al. (eds.) *Econophysics of Wealth Distributions*, Springer,
Milan, Italy, 2005.

Di Giovanni J., Andrei A. Levchenko, A., and Rancière, R. (2011) 'Power laws in firm size and openness to trade: measurement and implications', *Journal of International Economics*, vol. 85, no. 1, pp. 42-52.

Embrechts, P., Klüppelberg, C., and Mikosch, T. (1997), *Modelling Extremal Events for Insurance and Finance*, Berlin, Springer-Verlag.

Fujiwara, Y., Di Guilmi, C., Aoyama, H., Gallegati, M., and Souma, W. (2004), 'Do Pareto-Zipf and Gibrat laws hold true? an analysis with European firms', *Physica A*, vol. 335, pp. 197-216.

Gabaix, X. and Landier, A. (2008), 'Why has CEO pay increased so much?', *Quarterly Journal of Economics*, vol. 123, no. 1, pp. 49-100.

Gabaix, X. and Ibragimov, R. (2011). 'Rank - ½: A Simple Way to Improve the OLS Estimation of Tail Exponents', *Journal of Business and Economic Statistics*, vol. 29, no. 1, pp24-39.

Gabaix, X. (2016). 'Power Laws in Economics: An Introduction.' Journal of Economic Perspectives, vol. 30, no.1, pp. 185-206.

Hamilton, S. (2012), 'New dimensions in regulatory compliance – building the bridge to better compliance', *eJournal of Tax Research*, vol. 10, no. 2, pp. 483-531.

Heckman, J. (1979), 'Sample selection bias as a specification error', *Econometrica*, vol. 47, no. 1, pp. 153–61.

Henry, J. and Hsieh, P. (2009), 'Extreme value analysis for partitioned insurance losses', *Variance* vol. 3, pp. 214-238.

Levy, M. and Solomon, S. (1997), 'New evidence for the power law distribution of wealth', *Physica A*, vol. 242, pp. 90-94.

Lydall, H. (1959), 'The distribution of employment incomes', *Econometrica*, vol. 27, no. 1, pp. 110-115.

Mandelbrot, B. (1960), 'The pareto-levy law and the distribution of income', *International Economic Review*, vol. 1, no. 2, pp. 79-106.

Mantegna, R. and Stanley, H. (2000), *An Introduction to Econophysics: Correlations and Complexity in Finance*. Cambridge, Cambridge University Press.

Montroll, E. and Shlesinger, M. (1982), 'On 1/f noise and other distributions with long tails', *Proceedings of the National Academy of Science, USA* vol. 79, pp. 3380-3383.

Newman, M. (2005), 'Power laws, Pareto distributions and Zipf's law', *Contemporary Physics*, vol. 46, pp. 323-351.

Nirei, M. and Souma, W. (2007), 'Two factor model of income distribution Dynamics', *Review of Income and Wealth*, vol. 53, no. 3, pp. 440-459.

Pareto, V. (1897), *Le Cours d''Economie Politique*, London, Macmillan.

Petrick, K. (2002), 'Corporate profits: profits before tax, profits tax liability, and dividends', Methodology paper. Washington, D.C., U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Economic Analysis.

Rosen, S. (1981), 'The Economics of Superstars', American Economic Review, vol. 71, no. 5, pp. 845–58.

Simon, H. (1957), 'The compensation of executives', *Sociometry*, vol. 20, no. 1, pp. 32-35.

Slemrod, J. (2004), 'The economics of corporate tax selfishness', *National Tax Journal*, vol. 57, pp. 877-899.

U.S. Government Accountability Office (GAO), (2013), *Corporate Tax Compliance: IRS Should Determine Whether Its Streamlined Corporate Audit Process Is Meeting Its Goals*, GAO-13-662, Washington, D.C.

U.S. Internal Revenue Service (1996), *Federal Tax Compliance Research: Individual Income Tax Gap Estimates for 1985, 1988, and 1992*, Publication 1415 (Rev. 4-96).

Yakovenko, V. and Silva, A. (2005), 'Two-class structure of income distribution in the USA: exponential bulk and power-law tail', in A. Chatterjee et al. (eds.) *Econophysics of Wealth Distributions*, Springer, Milan, Italy.

Zipf, G. (1949), *Human Behavior and the Principle of Least Effort*, Cambridge, Addison-Wesley.

5 Estimates of the Tax Year 2014–2016 Employment Tax Underreporting Tax Gap

5.1 Introduction

"Employment taxes" for tax gap include social security and Medicare taxes under the Federal Insurance Contributions Act (FICA) and the Self-Employment Contributions Act (SECA), payments for federal unemployment insurance under the Federal Unemployment Tax Act (FUTA), and railroad retirement under the Railroad Retirement Tax Act (RRTA). The estimate of the employment tax underreporting tax gap presented in this report covers taxes associated with FICA, FUTA, and SECA. Tax associated with RRTA is excluded due to lack of available compliance data. The FICA and FUTA taxes associated with employers of agricultural and household workers are also excluded from the estimates due to lack of compliance data. Therefore, the estimate of the employment tax underreporting tax gap presented in this report should be considered an underestimate of the "true" tax gap because estimates for some components are not available.

The component of the employment tax underreporting gap estimate associated with self-employment income, or SECA, is based on underreported income data from the TY 2014-2016 NRP individual income tax reporting compliance studies, adjusted for undetected noncompliance. The tax effect was estimated by the tax calculator as described in the individual income tax methodology chapter of this report. This methodology is similar to the prior tax gap estimate for TY 2008-2010 but uses more recent data.

The components of the employment tax underreporting tax gap estimate that are associated with FICA and FUTA are estimated using information from the National Research Program (NRP) Employment Tax (ET) Study for TYs 2008-2010. The NRP data are used to estimate compliance rates for FICA and FUTA taxes for TY 2008-2010, which are then applied to TY 2014-2016 reported data for the population of filers to generate estimates of underreported FICA and FUTA taxes for the TY 2014-2016 timeframe. It is estimated that the average annual FICA and FUTA employment tax underreporting tax gap for the TY 2014-2016 timeframe is a combined $29 billion, with $28 billion from underreported FICA taxes and $1 billion from underreported FUTA taxes. The rest of the discussion in this section provides more information about the NRP Employment Tax (ET) Study and how the new estimates were produced.

5.2 National Research Program Employment Tax Study for Tax Years 2008-2010

As noted earlier, the National Research Program conducts reporting compliance studies for several different kinds of tax. The NRP ET Study covered tax years 2008 through 2010 and used the population of Form 941 filers as its sample frame. The Form 941 is the form generally used by employers to report FICA taxes as well as income tax withholding on a quarterly basis. The population of Form 941 filers covers the majority of FICA taxes reported and paid: roughly 93 percent of employers who reported FICA taxes in the TY 2014-2016 timeframe reported them on the Form 941, and the amount of FICA taxes reported on the Form 941 accounted for over 99 percent of all FICA taxes reported during this period. Although the NRP ET sample is not explicitly representative of the population of employers filing Form 940, the form used to report FUTA taxes, it nonetheless covers the majority of FUTA taxes reported and paid as well: in the TY 2014-2016 timeframe, roughly 96 percent of FUTA taxes reported on the Form 940 were reported by employers who also filed a Form 941.

The primary stratification of the NRP ET sample is by business operating division (BOD). The three BODs represented in the sample are Small Business/Self-Employed (SB/SE), Large Business and International (LB&I) and Tax Exempt and Government Entities (TEGE). The operating divisions conducted the audits for the appropriate employer types for the NRP ET Study. The sample size for each employer type was constrained by operating divisions based on their ability to commit examination resources. The final sample size used for the analysis is 6,766 entities that filed at least one Form 941 during tax years 2008 through 2010: 4,317 in SB/SE, 138 in LB&I, and 2,311 in TEGE. The TEGE entities can be further divided into tax exempt organizations (1,822) and local government entities (489). Because the sample sizes were constrained by the BODs, the samples could not be designed to meet any specific research objectives. This may limit the ability to make inferences beyond the most general for some subgroups in the sample.

5.3 NRP sample coverage of FICA and FUTA taxes

As noted above, the population of Form 941 filers covers the majority of FICA taxes reported and paid. However, FICA taxes may be reported on other forms besides the Form 941. Form 944 is similar to Form 941 but is required on an annual rather than quarterly basis. Its use is limited to small employers whose annual liability for social security, Medicare and withheld federal income taxes is $1,000 or less. Form 944 filers account for less than 2 percent of employers reporting FICA taxes during the TY 2014-2016 period and the FICA taxes they report amount to less than 0.1 percent of all reported FICA taxes. Employment taxes paid by household employers are reported on Form 1040, Schedule H, while employers who pay wages to agricultural workers generally report employment taxes on Form 943. Employers of household workers and employers of agricultural workers each represent 3 percent of all employers reporting FICA taxes in TY 2014-2016, while FICA taxes reported on the Form 1040, Schedule H account for less than 0.1 percent of all FICA taxes reported and FICA taxes reported on the Form 943 amount to less than 0.5 percent of all FICA taxes reported in this period.

The employers that report employment taxes on a form other than Form 941 were not included in the NRP ET sample, which means that the NRP does not provide information about the employment tax reporting compliance for these other subsets of employers. For purposes of tax gap estimation, it is assumed that the Form 944 filers have compliance behavior that is similar enough to the Form 941 filers such that compliance rates from the Form 941 study can be projected to them. The same assumption is not made for household employers or employers of agricultural workers; instead, any underreporting of employment tax associated with these employers is omitted from the estimate of the employment tax underreporting gap.

Certain other Form 941 filers were excluded from the NRP sample: federal and state governments, large corporations identified as Coordinated Industry Cases (CIC) (generally those corporations with assets of at least $250 million), foreign subsidiaries, Indian Tribal Governments, and employers covered by the Maritime Industry Credit Freeze.[39] Together these exclusions accounted for less than 0.1% of employers filing Form 941 in a typical quarter in 2014-2016. However, the excluded employers account for a larger share of reported FICA taxes: roughly 14 percent of FICA

[39] Returns filed by churches were sampled in all three years but were excluded from the 2008 sample and not audited for that tax year; their audit results are included in the 2009 and 2010 samples. Sample weights are adjusted so that any analysis that combines the three years into annual averages are roughly equivalent to having churches in the sample for all three years.

taxes reported on Forms 941 in a typical quarter were reported by employers not represented in the NRP sample, with roughly 8 percent attributed to CIC entities, 4 percent attributed to Federal government employers, 2 percent attributed to state government employers, and just 0.2 percent attributed to foreign subsidiaries, Indian Tribal Governments and employers covered by the Maritime Industry Credit Freeze.

Because the NRP ET sample is the population of Form 941 filers, it is not necessarily a representative sample of Form 940 filers, which raises the concern that it might not accurately reflect overall FUTA tax compliance. However, as noted above, for the period TY 2014-2016, 96 percent of FUTA taxes reported on the Form 940 are reported by employers who also file Form 941, indicating that the Form 941 sample yields a high degree of coverage of the Form 940 filing population. The exclusions from the Form 941 sample will reduce the extent of the coverage of the Form 940 population somewhat but, nonetheless, the high degree of overlap suggests that the NRP sample of Form 941 filers should be sufficient for producing reliable estimates of FUTA tax compliance.

5.4 Compliance estimates

In determining the compliance of individual firms or entities in the sample, we use the NRP examiner-recommended adjustments, which are reported separately for FICA and FUTA. This means that the employment tax underreporting tax gap for employers for FICA and FUTA does not include any errors arising from worker misclassification that are protected by Section 530 or reduced by the Classification Settlement Program, nor does it include any adjustments that the examiner considers de minimis.[40]

The measure of compliance that is developed from the NRP data is the voluntary reporting rate (VRR). This is defined as the amount of tax that was reported by employers divided by the amount of tax that should have been reported by those employers. The VRR is calculated for FICA and FUTA separately. The NRP ET Study further allows the estimation of VRRs separately by BOD, which provides somewhat more insight into how compliance behavior varies across different types of employers. Previous estimates of the VRR for FICA and FUTA are based on aggregating all types of employers.

Table 5-1 on page 59 shows findings from the NRP ET Study regarding FICA and FUTA compliance by BOD, estimated to the population. The BOD-level analysis shows that the VRRs for both LB&I and TEGE returns are higher than the VRR for SB/SE returns as a group. These estimates also suggest that compliance may have deteriorated slightly since the last study of employment tax was conducted for 1984 under the Strengthening Voluntary Compliance (SVC) 1 initiative. This was a program similar to ones conducted under the Taxpayer Compliance Measurement Program (TCMP). Prior estimates of the VRR based on the SVC-1 for FICA taxes

[40] Section 530 of the Revenue Act of 1978 provides relief from federal employment tax obligations for employers that have incorrectly classified workers as nonworkers and that meet certain conditions. The Classification Settlement Program is another program for resolving employment tax liability available to employers who do not meet all of the conditions for Section 530 but may meet some of them; the employer is offered the opportunity to reclassify workers prospectively and to pay a reduced tax assessment that is generally limited to tax liability for a single year. De minimis adjustments are those where the employer has made an error that would result in a small tax adjustment and the examiner uses his or her discretion to waive the error and not assess any unpaid tax.

and FUTA taxes were 98.2 percent and 92.4%, respectively, compared with VRR estimates of 96.7 percent and 87.9 percent based on the NRP ET Study.

For purposes of developing the FICA and FUTA employment tax underreporting tax gap estimates, these VRR estimates are applied by BOD to the populations of Form 941 filers, Form 940 filers, and Form 944 filers for TYs 2014-2016 to estimate the amount of unreported FICA and FUTA taxes by employers in those years. Implicit in this methodology is the assumption that the employers excluded from the NRP sample have the same compliance rate as other similar employer types as determined by BOD. Thus, ignoring some data discrepancies, federal and state government employers are generally assumed to have the same compliance rates as other TEGE employers, and CIC entities are assumed to have the same compliance rates as other LB&I employers. Most of the other three small categories are classified as TEGE (mostly Indian Tribal Governments) but some are SB/SE and a small number are LB&I. The VRR estimates for FICA taxes are also applied to Form 944 filers.

Table 5-2 on page 60 shows the estimates of annual averages of underreported FICA and FUTA taxes for TY 2014-2016 using this method. As shown, it is estimated that the FICA and FUTA employment tax underreporting gap for TY 2014-2016 is a combined $29 billion, with $28 billion from underreported FICA taxes and $1 billion from underreported FUTA taxes.

Table 5-1: Estimates of reported and assessed amounts for FICA and FUTA using NRP ET Study, annual averages, TY 2008-2010

FICA: Social Security + Medicare (Form 941)								
BOD	Number of entities in population (thousands)	Number filing Form 941 and reporting positive FICA taxes (thousands)	Number that had additional FICA tax assessed by exam (thousands)	Total number that should have reported positive FICA tax on Form 941 (thousands)	Amount of FICA tax reported on Form 941 (computer) (billions) (a)	Additional amount of FICA tax that was assessed by exam (billions) (b)	Total amount of FICA tax that should have been reported on Form 941 (billions) (c)	Estimated VRR (a)/(c)
SB/SE	5,385	5,137	2,437	5,214	$259.5	$18.5	$278.1	93.3%
LB&I	145	141	84	142	$253.1	$2.6	$255.7	99.0%
TEGE	458	445	119	446	$128.9	$0.7	$129.6	99.5%
Total	5,987	5,723	2,640	5,802	$641.5	$21.9	$663.5	96.7%
FUTA (Form 940)								
BOD	Number of entities in population (thousands)	Number filing Form 940 and reporting positive FUTA tax (thousands)	Number that had additional FUTA tax assessed by exam (thousands)	Total number that should have reported positive FUTA tax on Form 940 (thousands)	Amount of FUTA tax reported on Form 940 (computer) (billions) (a)	Additional amount of FUTA tax that was assessed by exam (billions) (b)	Total amount of FUTA tax that should have been reported on Form 940 (billions) (c)	Estimated VRR (a)/(c)
SB/SE	5,385	4,960	1,271	5,162	$3.9	$0.9	$4.9	81.0%
LB&I	145	141	9	141	$2.7	$0.0*	$2.7	99.9%
TEGE	458	74	11	78	$0.1	$0.0*	$0.1	96.7%
Total	5,987	5,175	1,291	5,381	$6.8	$0.9	$7.7	87.9%

* Less than $50 million.

Table 5-2: TY 2014 to TY 2016 Employment Tax Underreporting Gap Estimates using NRP ET Study (billions)

	FUTA (Form 940)			SS + Medicare (Form 941 + Form 944)		
Tax Year	Reported Tax	Estimated Underreporting Gap	Estimated True Tax Liability	Reported Tax	Estimated Underreporting Gap	Estimated True Tax Liability
2014	9	1	10	929	26	956
2015	9	1	10	974	28	1,002
2016	8	1	9	1,006	29	1,035
Annual average	**9**	**1**	**10**	**970**	**28**	**997**

6 Estimates of the Tax Year 2014–2016 Estate Tax Underreporting Tax Gap

6.1 Introduction

The estate tax underreporting tax gap estimate is based on applying the methodology used to estimate the TY 2006 estate tax underreporting tax gap to new data. The original methodology was developed under contract with Brian Erard. Operational audit data were combined with a random sample of tax returns filed timely for tax years 2011 – 2016 in order to predict underreported tax on unaudited returns using an econometric model. Each tax year was estimated separately and a Voluntary Reporting Rate (VRR) was then calculated for each tax year. The VRR is defined as the ratio of the amount of tax reported to the amount of tax that should have been reported. The estimated VRR for each tax year was then applied to reported estate tax for the population of estate tax filers. Reported estate tax was calculated from return information obtain from the Business Return Transaction File (BRTF) data. The annual results were averaged to develop the revised TY 2011–2013 estimate and the TY 2014–2016 estimate. The revised estate tax underreporting tax gap estimate for TY 2011–2013 is estimated to be $1.0 billion and the TY 2014 – 2016 estimate is also $1.0 billion.

6.2 Estate Tax Underreporting Tax Gap Estimates

6.2.1 Data

6.2.1.1 Estate Tax Return Sample

The Estate Tax Return Sample (ETRS) is a stratified random sample of estate tax returns collected by IRS Statistics of Income (SOI). The sample is taken every year with returns filed in processing years (PY) 2011- 2019 used for this analysis. The data includes demographic information about the decedent and return information from Form 706, the estate tax return. The TY 2011 through TY 2019 samples were pooled and then divided into separate subsamples based on the year of death of the decedent since the tax year of the return is the same as the year of death. The samples were then further restricted to timely filed returns.

6.2.1.2 Audit Information Management System (AIMS)

The AIMS closed case database contains return-level examination results from closed examinations. Returns from the ETRS were matched to AIMS data to obtain the audit result, recommended additional tax, for closed cases.

6.2.1.3 Business Return Transactions File (BRTF)

The BRTF contains information transcribed from the population of originally filed tax returns, including Form 706, the estate tax return. The final estate tax underreporting tax gap estimates apply the model estimated VRR to the actual population reported total estate tax from the BRTF data.

6.2.2 Model Estimated Voluntary Reporting Rate

The unweighted and weighted distribution of audits based on the ETRS matched to AIMS is shown in Table 6-1 for data from tax years 2011 through 2016. The model-based estimated estate tax underreporting tax gap estimates are also shown. As Table 6-1 shows, the estimated VRRs (weighted to the population) ranged from 91 percent to 96 percent over these six tax years.

Table 6-1: Tax Year 2011 – 2016 Estate Tax Underreporting Tax Gap Model Results ($ are in Millions)

Tax Year	Audit?	Sample Count	Weighted Population	Weighted Reported Tax	Weighted Audit Result	Weighted Underreporting Tax Gap	VRR
2011	**No**	2,936	5,190	$2,251	N/A	$436	84%
	Yes	2,339	3,420	$8,161	$455	$476	94%
	Total	**5,275**	**8,609**	**$10,412**		**$913**	**92%**
2012	**No**	3,820	7,800	$5,503	N/A	$214	96%
	Yes	1,123	1,616	$7,075	$511	$431	94%
	Total	**4,943**	**9,416**	**$12,579**		**$645**	**95%**
2013	**No**	4,016	8,010	$4,730	N/A	$845	85%
	Yes	1,567	2,223	$11,469	$673	$668	94%
	Total	**5,583**	**10,233**	**$16,199**		**$1,514**	**91%**
2014	**No**	5,582	8,648	$5,676	N/A	$655	90%
	Yes	1,820	2,376	$9,879	$998	$909	92%
	Total	**7,402**	**11,024**	**$15,556**		**$1,564**	**91%**
2015	**No**	6,040	9,539	$7,204	N/A	$578	93%
	Yes	1,677	2,400	$10,712	$738	$535	95%
	Total	**7,717**	**11,939**	**$17,916**		**$1,113**	**94%**
2016	**No**	6,046	9,919	$7,264	N/A	$311	96%
	Yes	1,523	2,247	$12,320	$563	$606	95%
	Total	**7,569**	**12,166**	**$19,584**		**$916**	**96%**

6.2.3 Final Estimates

Table 6-2 shows the final estate tax underreporting tax gap estimates based on applying the estimated VRR for each tax year from Table 6-1 to the actual population reported tax amount from the BRTF.

Table 6-2: Revised TY 2011–2013 and TY 2014–2016 Estate Tax Underreporting Tax Gap Estimates ($ are in Millions)

Tax Year	VRR	Population Reported Tax	Final Underreporting Tax Gap
2011	92.1%	$10,492	$898
2012	94.6%	$12,505	$721
2013	91.4%	$15,958	$1,495
Revised 2011-2013	**92.6%**	**$12,985**	**$1,038**
2014	90.4%	$15,628	$1,660
2015	93.2%	$17,966	$1,320
2016	95.7%	$19,933	$889
2014-2016	**93.3%**	**$17,842**	**$1,290**

6.3 Appendix A: Estate Tax Underreporting Tax Gap Methodology

6.3.1 Model Specification

The Erard methodology consists of estimating four equations jointly: the probability of audit, the probability of underreported tax conditional on an audit, the amount of underreported tax conditional on a positive recommendation, and the amount of overreported tax. Tax change in this analysis is defined as the recommended tax change by the examiner, which may differ from the final assessed amount after appeals.

6.3.1.1 Probability of Audit

The probability of audit is modeled using a probit specification:

$$A^* = \beta'_A x_A + \varepsilon_A \quad (1).$$

In equation (1), A^* is a latent variable representing the index of the likelihood that a return will be audited, $x_{A,}$ is a vector of return characteristics, β'_A is a vector of coefficients to be estimated, and ε_A is a standard normal random disturbance. In the data we do not observe A^*, instead we observe A which is conditional on A^*:

$$A = \begin{cases} 1\,(\text{Audit}) & A^* > 0 \\ 0\,(\text{No audit}) & \text{otherwise} \end{cases}$$

6.3.1.2 Probability of Detected Underreporting

The probability of positive tax change conditional on an audit taking place is also modeled using a probit specification:

$$P^* = \beta_P' x_P + \varepsilon_P \quad (2).$$

In equation (2), P^* is a latent variable representing the index of the likelihood of a positive tax change, x_P is a vector of return characteristics, β_P' is a vector of coefficients to be estimated, and ε_P is a standard normal random disturbance. In the data we do not observe P^*, instead we observe P which is conditional on A^* and P^*:

$$P = \begin{cases} 1 \left(\text{Positive tax change recommended}\right) & A^* > 0 \text{ and } P^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

6.3.1.3 Log of Positive Tax Change

The amount of underreported tax conditional on an audit taking place and the recommended tax change being positive is modeled using a log-normal specification:

$$ln(R) = \beta_R' x_R + \varepsilon_R \quad (3).$$

In equation (3), $ln(R)$ represents the natural log of the positive tax change, x_R, is a vector of return characteristics, β_R' is a vector of coefficients to be estimated, and ε_R is a normally distributed random disturbance. We observe R in the data but it is conditional on A^* and P^*:

$$R = \begin{cases} R \left(\text{Amount of positive tax change }\right) & A^* > 0 \text{ and } P^* > 0 \\ 0 & \text{otherwise} \end{cases}$$

6.3.1.4 Log of Negative Tax Change

The amount of overreported tax conditional on an audit taking place and the recommended tax change being nonpositive is modeled using a displaced log-normal specification:

$$ln\left(M^* + D\right) = \beta_M' x_M + \varepsilon_M \quad (4).$$

In equation (4), M^* is a latent variable that indexes the amount of the negative tax change, x_M, is a vector of return characteristics, D is a displacement parameter that is estimated, β_M' is a vector of coefficients to also be estimated, and ε_M is a normally distributed random disturbance. The displaced log-normal specification is chosen to account for both zero and negative tax changes. In the data we do not observe M^*, instead we observe M which is conditional on M^*, A^*, and P^*:

$$M = \begin{cases} M^* \ (\text{Amount of negative tax change}) & M^* > 0,\ A^* > 0,\ P^* <= 0 \\ 0 & \text{otherwise} \end{cases}$$

6.3.1.5 Free Correlations

To control for selection bias, the model allows for free correlations (ρ_{AP}, ρ_{AR}, ρ_{PR}) between ε_A, ε_P, and ε_R. These correlations allow for the possibility that unobserved information about the audit selection process may also affect the likelihood or amount of underreported tax. If there is information that we do not observe in the data (e.g. an audit selection filter) that increases the likelihood of a return being selected for audit, that same unobserved information may also be correlated with the likelihood of the audit resulting in a positive assessment. Without allowing for this correlation, the model may overestimate the amount of noncompliance associated with the unaudited returns.

6.3.2 Model Estimation

The model is estimated using the method of maximum pseudo-likelihood where the likelihood function is weighted by the sample weights (scaled to the sample size to improve the stability of the model).[41]

The likelihood function as specified by Erard (1999) is:

Case 1: No Audit

For returns not subject to an audit, only the audit equation applies and the likelihood value (L_1) represents the probability that the return would not be audited:

$$L_1 = \Phi(-\beta_A x_A)$$

where Φ represents the standard normal cumulative distribution function (cdf).

Case 2: Audited, Negative Tax Change

For audited returns with a negative recommended tax change the likelihood value (L_2) is the probability density function (pdf) for the observed negative recommendation (M) multiplied by the joint probability of the return being audited and the recommendation being nonpositive:

$$L_2 = \frac{1}{\sigma_M (M + D)} * \varphi\left(\frac{ln(M + D) - \beta_M x_M}{\sigma_M}\right) * BN(-\beta_P x_P, -\beta_A x_A, -\rho_{AP})$$

where φ represents the standard normal pdf and BN represents the Φ standard bivariate normal cdf.

[41] Scaling the weights can help reduce computational errors in the optimization routines without affecting the solution.

Case 3: Audited, No Tax Change

For audited returns that received no recommended tax change the likelihood value (L_3) represents the probability of no recommendation multiplied by the joint probability of the return being audited and the recommendation being nonpositive.

$$L_3 = \Phi\left(\frac{ln(D) - \beta_M x_M}{\sigma_M}\right) * BN(-\beta_P x_P, -\beta_A x_A, -\rho_{AP})$$

Case 4: Audited, Positive Tax Change

For audited returns that received a positive recommended tax change the likelihood value (L_4) represents the probability distribution function (pdf) for the observed positive recommendation times the conditional joint probability that the return was audited and the recommendation was positive given the observed positive recommendation.

$$L_4 = \frac{1}{\sigma_R R} * \varphi\left(\frac{ln(R) - \beta_R x_R}{\sigma_R}\right) *$$
$$BN\left(\frac{\beta_A x_A + \rho_{AR}\frac{(ln(R) - \beta_R x_P)}{\sigma_R}}{\sqrt{1-\rho_{AR}^2}}, \frac{\beta_P x_P + \rho_{PR}\frac{(ln(R) - \beta_R x_R)}{\sigma_R}}{\sqrt{1-\rho_{PR}^2}}, \frac{\rho_{AP} - \rho_{AR}\rho_{PR}}{\sqrt{1-\rho_{AR}^2}\sqrt{1-\rho_{PR}^2}}\right)$$

6.3.3 Variable Specification

Return characteristics, demographic information, and asset valuations are available in the ETRS to estimate the equations of the model. The ETRS has around 40 asset variables and 20 deduction variables. Each of these variables could be transformed and potentially enter a model as a categorical variable or continuous variable. Categorical variables would include dummy variables (equal to 1 if the original variable is present, otherwise 0) or some other intervalization represented by a series of dummy variables. Continuous variables may include ratio variables and log-transformations.[42] The ratio variables used are created by dividing the original variable by the sum of total gross estate and adjusted taxable gifts.

Audit filters are another type of categorical variable. Potential audit filters were developed through correspondence with the Estate and Gift Tax Program and based on audit filters used in the selection of the 1992 Estate Post-Audit Study.[43] In some instances, model variables are proxies for the audit filter and in other cases there are no model variables associated with the filter because the information needed to program the audit filter was not available.

[42] Ratio values above 1.00 were set equal to 1.00. Since one cannot take the log of zero, 1.00 was added to variables with zero values prior to taking the log.
[43] See Eller (2001) http://www.irs.ustreas.gov/pub/irs-soi/92esaudt.pdf.

6.4 References

Erard, Brian. 1999. "Estate Tax Underreporting Gap Study: A Report Prepared for the Internal Revenue Service Economic Analysis and Modeling Group." Order number TIRNO-98-P-00406. Internal Revenue Service.

Eller, Martha Britton. 2001. Audit Revaluation of Federal Estate Tax Returns, 1992." SOI Bulletin (Publication 1136), Winter 2000-2001. Internal Revenue Service. Washington, D.C., http://www.irs.ustreas.gov/pub/irs-soi/92esaudt.pdf

Eller, Martha Britton, Brian Erard and Chih-Chin Ho. 2001. "Noncompliance with the Federal Estate Tax." Rethinking Estate and Gift Taxation, ed. Gale, William G., James R. Hines Jr. and Joel Slemrod. Brookings Institution Press. Washington, D.C., pp. 375- 421.

Fay, R. E. 1984. "Some Properties of Estimates of Variance Based on Replication Methods." Proceedings of the Section on Survey Research Methods, American Statistical Association, Washington D.C., pp. 495 – 500.

Fay, R. E. 1989. "Theory and Application of Replicate Weighting for Variance Calculations." Proceedings of the Section on Survey Research Methods, American Statistical Association, Washington D.C., pp. 212 – 227.

McCarthy, P. J. 1969 "Pseudo-Replication: Half Samples." Review of the International Statistical Institute. Vol. 37 No. 3, pp. 239 – 264.