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Measuring the Size, Growth and
Determinants of Income Tax Evasion in
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Feige, Edgar L. and Cebula, Richard

University of Wisconsin-Madison

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Richard Cebula and Edgar L. Feige

Abstract

This study empirically investigates the extent of non compliance with the tax code and the determinants of federal income tax evasion in the U.S. Employing the most recent data we find that 18-19% of total reportable income is not properly reported to the IRS, giving rise to a “tax gap” approaching \$500 billion dollars. Three time periods are studied, 1960-2008, 1970-2008, and 1980-2008. It is found across study periods that income tax evasion is an increasing function of the average effective federal income tax rate, the unemployment rate, public dissatisfaction with government, and per capita real GDP (adopted as a measure of income), and a decreasing function of the Tax Reform Act of 1986 (during its first two years of being implemented). Modest evidence of a negative impact of IRS audit rates on tax evasion is also detected.

Keywords: Underground economy; unreported economy; tax evasion; tax gap; non compliance; Federal income tax.

JEL Classifications: E26; H26; O17; E41; E52

America's Underground Economy: Measuring the Size, Growth and Determinants of Income Tax Evasion in the U.S

Richard Cebula¹ and Edgar L. Feige²

Introduction

Tax evasion effectively defrauds the government of legally due tax revenues, thereby reducing the government's ability to provide public services, while increasing the nation's debt burden. Noncompliance shifts real resources from honest taxpayers to dishonest evaders, and tax liabilities from present to future generations. Such inequities precipitate greater discontent with the government and further erode public revenues. In light of these consequences, economists strive to estimate the magnitude, composition, growth and determinants of tax evasion in the hope of implementing public policies likely to improve fiscal compliance.

In the U.S., noncompliance with the income tax is accomplished by underreporting taxable income and/or overstating allowable deductions. Since tax evasion is a punishable illegal behavior that individuals attempt to hide, measuring the magnitude of tax evasion and how it changes over time is a difficult and elusive task. The purpose of this study is to present new time series estimates of tax evasion in the US and then to use these estimates to analyze the determinants of income tax evasion.

The rich theoretical literature on tax evasion [Allingham & Sandmo (1972), Yitzhaki (1974), Falkinger (1988), Klepper, Nagin, & Spurr (1991), Das-Gupta (1994), Pestieau, Posen, & Slutsky (1994), Caballe & Panades (1997), Sandmo (2005) and Gahramanov (2009)] has been comprehensively reviewed and analyzed by Cowell (1990), Andreoni, Erard, and Feinstein (1998), Alm (1999), Franzoni (1999) and Slemrod (2007). The literature's theoretical models are inventive and mathematically elegant and endeavor to identify variables that are likely to affect tax compliance behavior. However, the plethora of behavioral assumptions and alternative model specifications often yield conflicting results regarding the expected signs and magnitudes of many

¹ Walker/Wells Fargo Endowed Chair in Finance, Jacksonville University, rcebula@ju.edu

² Professor Emeritus, University of Wisconsin-Madison, elfeige@wisc.edu

of the key variables believed to effect tax evasion. These theoretical ambiguities underscore the need for further empirical analysis to examine the determinants of tax evasion. The specific aim of the current study is to estimate how tax evasion in the U.S. has changed over time and to analyze the determinants of noncompliance behavior.

I. Measuring Tax Evasion

The first problem encountered in any empirical attempt to analyze the determinants of tax evasion is to define and estimate an appropriate measure of noncompliance. Measuring a behavior that individuals attempt to hide is inherently one of the more challenging problems faced by social scientists. Social scientists therefore rely on both direct and indirect approaches for measuring what is commonly referred to as the “underground economy.”

Andreoni, Erard, Feinstein (1998, p.836) claim that” the most reliable information about noncompliance is based on actual tax return information that has been thoroughly examined by auditors” as part of the IRS Taxpayer Compliance Measurement Program (TCMP) which attempts to measure “unreported income” and the national “tax gap”.³ However, the last TCMP undertaken by the IRS was for the tax year 1988 since these “audits from hell” were deemed to be overly intrusive. A less intrusive substitute for TCMP known as the National Research Program (NPR) was instituted in the 1990’s to estimate non compliance. Slemrod (2007, p.26) contends that these estimates represent “the most careful and comprehensive estimates of the extent and nature of tax noncompliance anywhere in the world”. However, as noted by Toder (2010) “there are some serious ‘gaps’ in the tax gap measure and these introduce substantial uncertainty into the measure.” The last IRS estimate of the U.S. tax gap was undertaken for the year 2001 and amounted to \$345 billion dollars. In what follows, we employ estimates of unreported income from the 1988 TCMP and the 2001 NPR as direct “benchmark” approximations of the level of noncompliance for the respective years. These benchmarks are then incorporated into a version of Feige’s (1989) general currency ratio model (GCM). Currency ratio models are the most common indirect method for estimating changes in tax evasion over time.

³ Clotfelter (1983, p. 336-37) and Feige (1989, p. 33-35) describe the IRS TCMP procedures for estimating unreported income and some of the shortcomings of the approach.

Our goal is to generate a time series estimate of the relative size of the fiscal underground economy, (the “unreported economy”) as measured by the ratio of unreported income (Y_u) to reported income (Y_o).⁴ Unreported income is the difference between the amount of income that should be reported to the tax authority (under full compliance with the tax code) and the amount actually reported, namely, adjusted gross income (AGI). The most common method for estimating the relative size of the unreported economy (Y_u/Y_o) relies on some variant of the general currency ratio model described in Feige (1989).

The most restrictive specification of the general currency ratio model [Cagan (1958), Gutmann (1977)] assumes that currency is the exclusive medium of exchange for unreported transactions, that the ratio of currency to checkable deposits remains constant except for changes induced by the growth of unreported income and that the amount of unreported income produced by a dollar of currency transacted in the unreported sector is the same as the amount of reported income produced by a dollar of currency transacted in the reported economy. In order to obtain a benchmark estimate of the size of the unreported sector, the restrictive model assumes that in some benchmark year (typically 1940) the underground economy (unreported income) was zero.⁵

In the analysis that follows, we relax the restrictive model with several important modifications. Since our concern is with estimating the amount of unreported income in the U.S., the first modification is to employ estimates of currency in circulation domestically (C_{dom}) rather than the total amount of currency in circulation (C). Despite widespread predictions of the advent of a “cashless society,” U.S. currency in circulation with the public amounted to more than \$2,900 per capita by the end of 2010. But American households and businesses admit to holding only 15% of this currency. Some fraction of U.S. currency is held abroad (the dollarization hypothesis) and some fraction is held domestically as a store of value and a medium of exchange for transactions involving the production and distribution of illegal goods and services (which are nevertheless taxable) and for transactions involving income that is not reported to the tax

⁴ The “unreported economy” is typically measured as $Y_u/Y_o = \alpha$. The “noncompliance ratio” is typically measured as $Y_u/(Y_u + Y_o) = \alpha/(1 + \alpha)$.

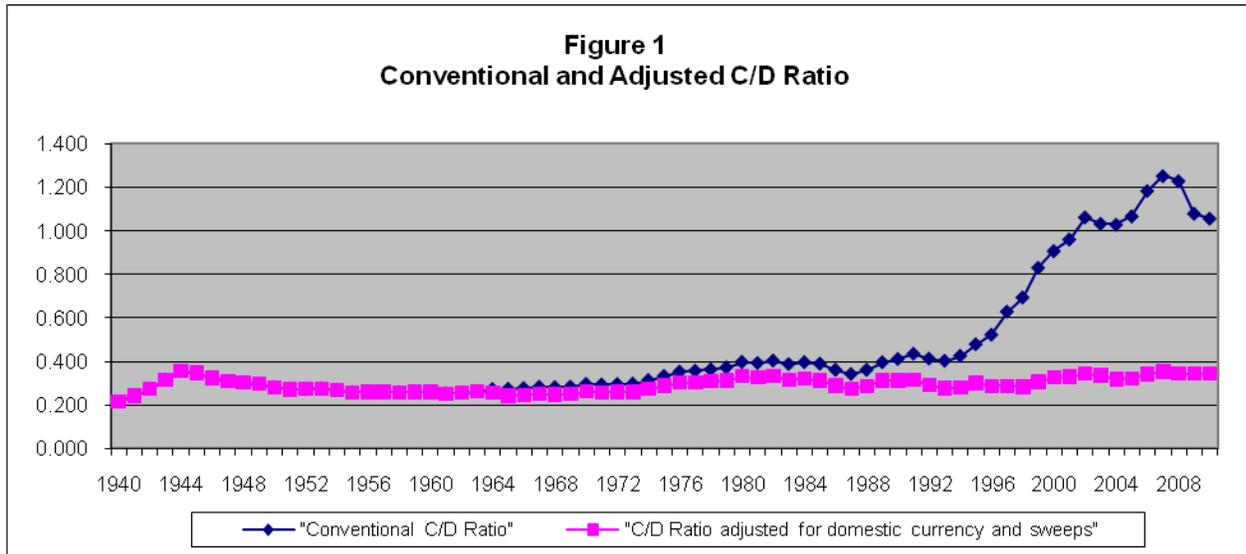
⁵ As described in Feige (1989) these restrictions imply that the *ratio* of unreported income (Y_u) to reported income (Y_o) can be estimated as follows:

$Y_u/Y_o = (C - koD)/(ko + 1) D$, where C = Currency, D = Checkable deposits and $ko = (C_o/D_o)$, the currency deposit ratio in the official economy which is observed in the year (1940) when the underground economy is assumed to be zero.

authority,(the underground economy hypothesis). Feige’s (2009) study of overseas currency concludes that between 30% and 36% of America’s currency is currently held abroad, and his new temporal estimates of overseas holdings are used to generate a time series of domestic currency which is employed in the present study.

The second refinement of the currency ratio model involves taking account of the technological innovations in the financial industry that significantly reduced the volume of “checkable deposits” (D) in the mid 1990’s.⁶ During this period, banks began to offer retail sweep programs, in which checkable deposits were swept into money market deposit accounts, enabling banks to profitably reduce the level of demand deposits subject to reserve requirements. During the first quarter of 1994 these “sweeps” amounted to only \$7.5 billion dollars but have subsequently increased to \$775 billion in 2008. By adjusting for these “sweeps” in our definition of “checkable deposits,” we take account of an important factor affecting the conventional C/D ratio which is unrelated to developments in the unreported economy.

Figure 1 displays the effects of these two adjustments by comparing the conventional C/D ratio employed in many published estimates of the underground economy with the new C/D ratio adjusted here for both *domestic* currency holdings and sweeps.



⁶ Checkable deposits are defined as the sum of demand deposits and other “checkable deposits”.

A further modification of the conventional currency ratio model is to drop the assumption that unreported income in 1940 was zero and instead employ an IRS benchmark estimate of unreported income for a year in which an independent estimate of the ratio $Yu/Yo_t = \alpha_t$ is available.⁷ Two benchmark years were chosen, the 1988 TCMP estimate⁸ and 2001 NPR based estimate. For the year 1988, the ratio of legal unreported income to total reported taxable income was 18.8 percent, whereas the ratio of legal unreported income to adjusted gross income was 14.5 percent. Our 1988 benchmark estimate for Yu/Yo is 16.7 percent, where Yu represents legal plus illegal unreported income and Yo represents AGI. We regard this as a lower bound estimate since the IRS acknowledges that “despite the intensity of the TCMP examinations, some income still goes undetected.”⁹

The most recent year for which the IRS published a “tax gap”¹⁰ estimate was 2001. The gross tax gap was estimated to be \$345 billion dollars.¹¹ In order to construct a benchmark estimate of Yu/Yo for 2001, we first divide the IRS tax gap estimate by the average marginal federal income tax rate from the NBER TAXSIM model in order to obtain an estimate of total unreported income (Yu). We then divide (Yu) by actual AGI (Yo) in order to obtain the benchmark estimate Yu/Yo for the year 2001. This benchmark underestimates the true value of Yu/Yo because the IRS tax gap excludes unpaid taxes on illegal income, and hence the unreported illegal income that we consider to be part of Yu .

⁷ Given α_t , the equation in footnote 5 can be solved for ko_t to derive a benchmark estimate for generating the temporal development of Yu/Yo .

⁸ IRS (1988, Table D-1, Table F1).

⁹ IRS (1988, p. A-5).

¹⁰ The tax gap is defined by the IRS “as the aggregate amount of true tax liability imposed by law for a given tax year that is **not paid voluntarily** and **timely**. It is important to emphasize that IRS estimates of the tax gap are associated with the **legal** sector of the economy only. Although tax is due on income from whatever source derived, legal or illegal, the tax attributable to income earned from illegal activities is extremely difficult to estimate.” IRS (2007, p.6).

¹¹ IRS (2007, p.1).

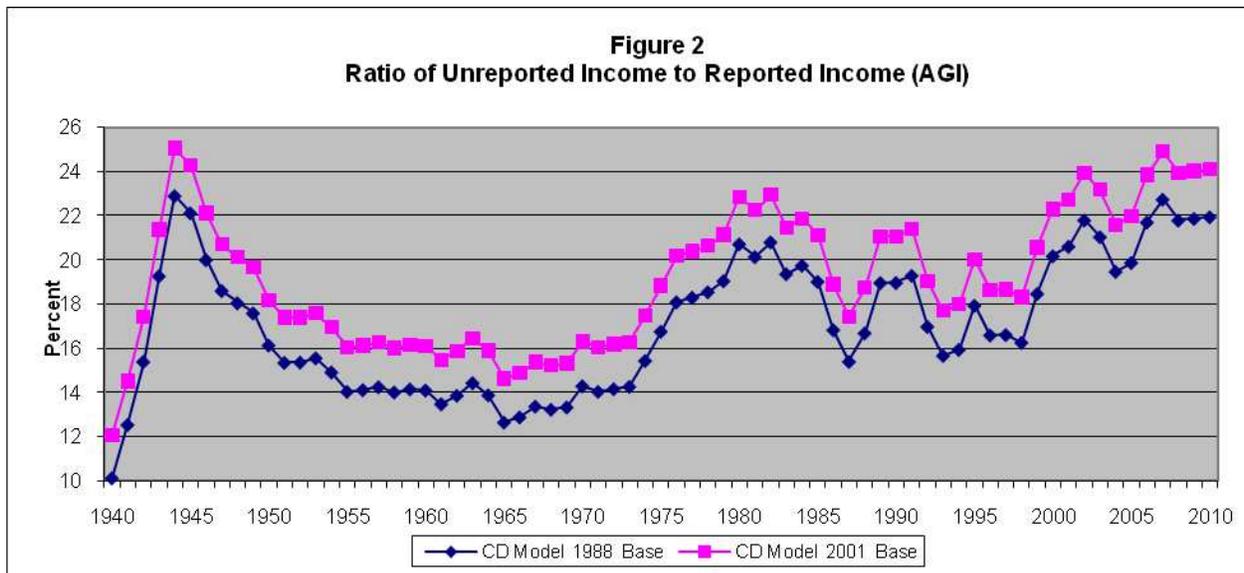
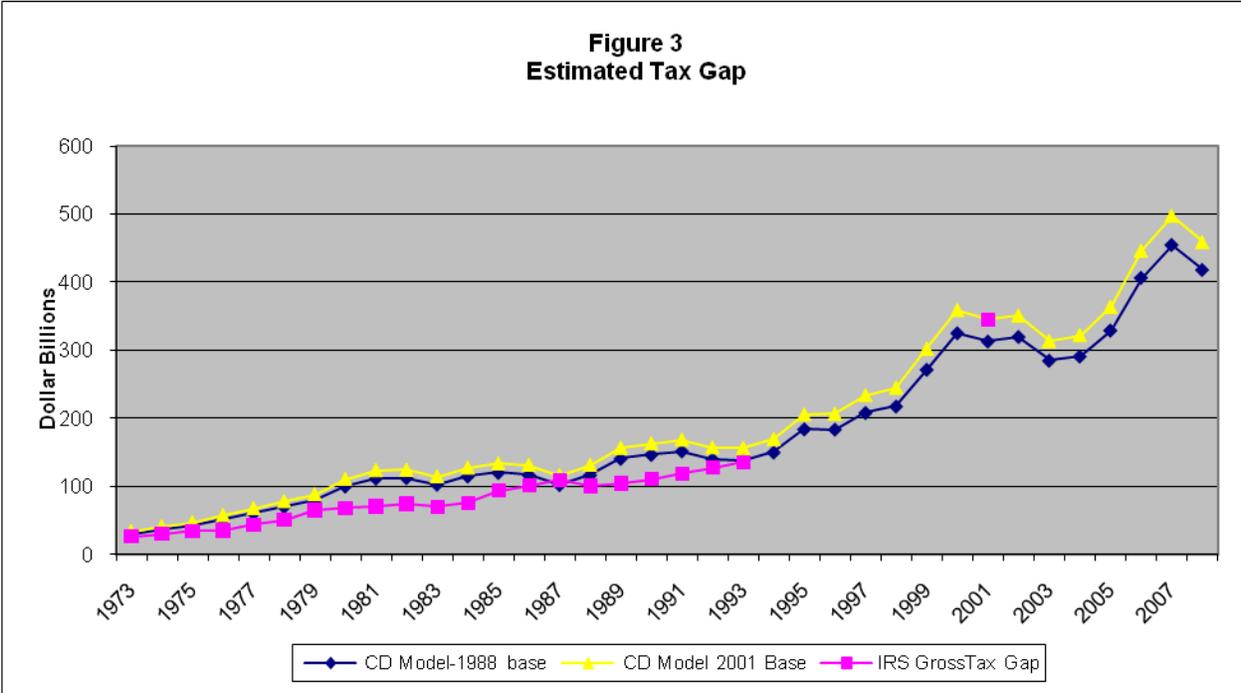


Figure 2 displays the adjusted currency model's time series estimates of the ratio of unreported income to reported income (AGI) based on the IRS benchmarks for 1988 and 2001 respectively. The percentage of unreported income rose dramatically during World War II, declined during the post war period and then remained roughly stable until 1973, when it again rose to a temporary peak in 1982. The 1980's and 1990's displayed considerable fluctuations in the Yu/Yo ratio which Cebula (1997) and Cebula et. al. (1998) showed could be explained by variations in tax rates, the public's dissatisfaction with government, and audit rates. During the past decade, the percentage of unreported income increased substantially, approaching the peak levels attained during the World War II period. By 2008 unreported income as a percent of AGI is estimated to range between 22 and 24 percent. These figures suggest a noncompliance ratio between 18-19 percent of total reportable income.

The implications for the estimated tax gap over the past four decades are displayed in Figure 3, which also includes the available IRS tax gap estimates. Since 2001, the tax gap appears to have increased dramatically, and by 2007 the gap peaked in the \$450 - \$490 billion dollar range.¹²

¹² The estimate for 2008 is based on a projection of AGI.



It should be noted that our estimate of both unreported income and the tax gap are based exclusively on the use of *domestic* currency in unreported activities. Recent attention has been focused on an additional tax gap resulting from income earned abroad in tax havens. Although we cannot trace the source of estimates of overseas tax haven evasion, figures as high as \$100 billion have been mentioned in the press. Taking account of the tax gap resulting from overseas tax havens, overall tax evasion may cost the U.S. government as much \$600 billion per year.

2. A Model of the Determinants of Non Compliance

Given our empirical estimates of the temporal path of the unreported economy, we now specify a model of noncompliance which we will estimate empirically. In this study, the *relative* probability that the *representative* economic agent will *not* report his/her taxable income to the IRS is treated as an increasing function of the expected gross benefits to the agent of not reporting income, *eb*, and as a decreasing function of the expected gross costs to the agent of not reporting income, *ec*. Thus, the ratio of the probability of not reporting income to the IRS, *pnr*, to the probability of reporting income to the IRS, *(1-pnr)*, is described for the representative economic

agent by:

$$(1) \quad pnr/(1-pnr) = f(eb, ec), f_{eb} > 0, f_{ec} < 0$$

Expressing probabilities in *relative* terms such as shown in equation (1) possesses the virtue that it reflects the form of the tax evasion data described above in Section 1, namely as the ratio of unreported to reported income.

Following Cagan (1958), Bawley (1982), Tanzi (1982), Clotfelter (1983), and Feige (1994), the gross expected benefits from *not* reporting income to the IRS are hypothesized to be an increasing function of the federal income tax rate. To reflect the federal income tax rate, most previous studies using official data for the U.S. have adopted either of two alternative measures: an average effective federal income tax rate (*AET*) or the maximum marginal federal income tax rate (*MAXT*). In this study, the *AET* measure of the income tax rate is adopted because, as argued in Feige (1994), this tax rate is likely to be a more representative measure of the income tax rate for a larger portion of the taxpaying public than *MAXT* would be. Accordingly, it is hypothesized, *ceteris paribus*, that:

$$(2) \quad eb = g(AET), g_{AET} > 0$$

The Tax Reform Act of 1986 (*TRA*) may have been perceived by at least some portion of the general public as an honest, good faith effort to reform, i.e., to simplify and increase the equity of the Internal Revenue Code. As Musgrave observed (1987, p. 59), “The Tax Reform Act of 1986 is the most sweeping reform since the early 1940s...” Indeed, the *TRA* did introduce a number of reforms, many of which are outlined in broad terms in Barth (1991), Barth and Brumbaugh (1992), Ott and Vegari (2003), and Sanger, Sirmans, and Turnbull (1990). For example, as observed in Ott and Vegari (2003, p. 279), “The Act introduced major cuts in the personal tax rate. When fully effective (1988) only two tax brackets set at 15 and 28 percent were to replace the 14 bracket tax schedule with rates in the range of 11 to 50 percent...[while it] broadened the tax base by reducing the itemized deduction.” Musgrave (1987, p. 59) further observes that prior to the *TRA*, a slow erosion of the income tax base had been occurring. Musgrave (1987, p. 57) was particularly

dismayed by the widening of tax loopholes and the emergence of high income tax shelters that had “...gained momentum in recent years and undermined the public’s faith in the income tax. “ In this vein, Barth (1991), Barth and Brumbaugh (1992), and Sanger, Sirmans, and Turnbull (1990) describe how the *TRA* decreased depreciation benefits from financial investments in residential as well as commercial real estate, established limitations on the tax deductibility of losses from “passive” investments that affected limited partnership syndications (including those involving real estate ventures), and terminated favorable capital gains treatment of real estate. Musgrave (1987, p. 59) also expressed concern that the “...compounding of the investment tax credit and accelerated depreciation diluted and distorted the base of the corporate income tax.” Musgrave (1987, p. 59) asserted that the *TRA* “...reversed these trends, a major accomplishment that all reformers will welcome.” As Barth (1991, pp. 45, 124) observes, among other things, under the *TRA* the 10 percent investment tax credit for the purchase of equipment was repealed, and the life of the investment was increased for depreciation purposes. Based on Musgrave’s (1987) arguments, as well as findings for an earlier study period in Cebula, Coombs, and Yang (2009), then, it is expected in the present study that taxpayers might well have favorably regarded the *TRA* and been less resentful of the Internal Revenue Code than before, at least initially. Thus, it is hypothesized here that at the time the *TRA* was being enacted and becoming effective (1986-1987) and also received the greatest publicity, reduced taxpayer resentment of the federal income tax system/Internal Revenue Code *would/could*, at least *temporarily*, have resulted in a reduced degree of aggregate income tax evasion, *ceteris paribus*. The reason this reaction to the *TRA* might be only *temporary* is revealed in the words of Slemrod (1992, p. 45), who argues that it would take at least some time for taxpayers “...to learn about and adjust to the new law [the *TRA*].” Consequently, it is hypothesized here that, for the period when the *TRA* was first implemented, 1986, through the year the *TRA* became “*de facto* fully effective,” 1987 (Barth (1991); Barth and Brumbaugh (1992)), the *eb* was reduced, whether because of either reduced taxpayer resentment or simply because it would take at least some time for taxpayers to fully understand the newly modified IRS Code and how to “deal” with it. Accordingly, (2) above is replaced by (3):

$$(3) \quad eb = j(AET, TRA), j_{AET} > 0, j_{TRA} < 0$$

Estimating with the *TRA* dummy variable (which can be regarded as a *de facto* control variable) so specified as to include years *after 1988* renders this variable statistically insignificant, a finding consistent with arguments in Slemrod (1992, p. 45), although the other findings in the model are not seriously affected by so specifying *TRA*. Accordingly, based our estimation results and the argument in Slemrod (1992, p. 45), it is argued here that *TRA* as specified above is the most useful form of this variable.

Next, as in Alm and Yunus (2009), it is expected that the higher the unemployment rate (*UN*), the greater the degree of aggregate income tax evasion, *ceteris paribus*. This expectation is based on the reasoning that the higher the *UN* level, the greater the extent to which the unemployed work in the “underground economy” and do not report income. Moreover, this effect may be reinforced to the extent that higher unemployment creates an incentive to engage in income tax evasion even for still-employed people to the degree that they try to covet extra funds (by under-reporting income) in the event of a possible future lay-off. Furthermore, the higher the real income level (*INC*), the greater the degree to which tax evasion is hypothesized in this study to occur, *ceteris paribus*, because higher income persons will tend to have greater access to and greater knowledge of ways in which to reduce income tax liabilities. For example, many higher income persons report income on a Schedule C, which often-times provides an opportunity to under-report income (Ali, Cecil, and Knoblett, 2001). Higher income persons arguably also have greater access to specialized tax lawyers and accountants who may enable them to more efficiently “limit” tax liabilities. Thus, equation (3) can be replaced by equation (4), as follows:

$$(4) \quad eb = j(AET, TRA, UN, INC), j_{AET} > 0, j_{TRA} < 0, j_{UN} > 0, j_{INC} > 0$$

Finally, following Feige (1994) and others, it can be argued that the greater the public’s dissatisfaction with government (*DIS*), the greater the secondary gain from not reporting or from under-reporting taxable income, *ceteris paribus*. The variable *DIS* is the so-called public dissatisfaction with government index (based on survey questions from the University of Michigan Institute for Social Research, 2009). This variable measures: (a) the degree to which the public distrusts public officials (other than the President) to fulfill their job obligations; (b) the degree to which the public regards government officials as dishonest; and (c) the degree to which the public

believes that government officials waste tax dollars. The value of the index ranges from -1.5 to +1.5, with a higher index value signifying a greater degree of dissatisfaction with government. Thus, (4) is replaced by (5):

$$(5) \quad eb = j(AET, TRA, UN, INC, DIS), j_{AET} > 0, j_{TRA} < 0, j_{UN} > 0, j_{INC} > 0, j_{DIS} > 0$$

The expected gross costs of not reporting income to the IRS are hypothesized to be an increasing function of the expected *risks/costs* thereof (Pestieau, Possen, and Slutsky, 1994; Erard and Feinstein, 1994; Caballe and Panades, 1997). In this study, to the representative economic agent, the expected risks/costs from not reporting or from underreporting taxable income to the IRS are enhanced by an increase in *AUDIT*, the percentage of filed federal income tax returns that is formally audited by IRS examiners/personnel, *ceteris paribus*. Indeed, the experience of an IRS tax audit could imply non-pecuniary ("psychic") costs as well as pecuniary costs (including outlays for legal or other representation, along with the value of one's own time) above and beyond any potential added taxes, penalties, and interest assessed by the IRS. This study adopts the probability of a formal audit as a measure of risk to the would-be tax evader. Thus, we have:

$$(6) \quad ec = j(AUDIT), j_{AUDIT} > 0$$

Substituting from (5) and (6) into (1) yields:

$$(7) \quad pnr/(1-pnr) = eb = j(AET, TRA, UN, INC, DIS, AUDIT) \\ j_{AET} > 0, j_{TRA} < 0, j_{UN} > 0, j_{INC} > 0, j_{DIS} > 0, b_{AUDIT} < 0$$

Let *AGI* represent the *actual total value of the aggregate federal adjusted gross income* in the economy, i.e., $AGI = UAGI + RAGI$, where *UAGI* is the dollar size of the *unreported aggregate federal adjusted gross income* in the economy, and *RAGI* is the dollar size of the *reported aggregate federal adjusted gross income* in the economy. It reasonably follows overall that:

$$(8) \quad UAGI = (pnr) * AGI$$

and

$$(9) \quad RAGI = (1-pnr)*AGI$$

It then follows that:

$$(10) \quad UAGI/RAGI = (pnr)*AGI/(1-pnr)*AGI = (pnr)/(1-pnr)$$

From (7) and (10), substitution for $pnr/(1-pnr)$ in (1) yields:

$$(11) \quad UAGI/RAGI = j(AET, TRA, UN, INC, DIS, AUDIT) \\ j_{AET} > 0, j_{TRA} < 0, j_{UN} > 0, j_{INC} > 0, j_{DIS} > 0, b_{AUDIT} < 0$$

3. Empirical Analysis

Based on the framework provided in (11) above, the following reduced-form equation is to be estimated:

$$(12) \quad (UAGI/RAGI)_t = a_0 + a_1 AET_{t-1} + a_2 TRA_t + a_3 UN_{t-1} + a_4 INC_{t-1} + a_5 DIS_{t-2} \\ + a_6 AUDIT_{t-2} + u$$

where:

$(UAGI/RAGI)_t$ = the ratio of the aggregate *unreported* federal adjusted gross income in year t to the aggregate *reported* federal adjusted gross income in year t, expressed as a percent;

a_0 = constant term;

AET_{t-1} = the average effective federal income tax rate in year t-1, expressed as a percent;

TRA_t = a binary (dummy) variable for the years 1986 and 1987: $TRA_t=1$ for the years 1986, 1987 and $TRA_t=0$ otherwise;

UN_{t-1} = percentage unemployment rate of the civilian labor force in year t-1;

INC_{t-1} = per capita real GDP in year t-1 (expressed in year 2000 dollars);

DIS_{t-2} = the mean value of the public dissatisfaction with government index, year t-2, with values lying between -1.5 and + 1.5;

$AUDIT_{t-2}$ = the percentage of filed federal personal income tax returns in year t-2 that was subjected to a formal IRS audit involving IRS examiners; and

u = stochastic error term.

The initial study period runs from 1960 through 2008, reflecting availability of the tax evasion data. In the interest of testing for robustness and consistency of results, as well as in the quest for potential additional insights, two additional study periods are also considered: 1970-2008 and 1980-2008. The data are annual. The data for AET were obtained from the Internal Revenue Service (2010, Table 6). The $AUDIT$ data were obtained from the Government Accounting Office (1996: Table I.1), and the U.S. Census Bureau (1994: Table 519, 1998: Table 550, 1999: Table 556, 2001: Table 546, 2010: Table 469). The TRA variable is a dummy variable; the Tax Reform Act of 1986 was actually signed into law by President Reagan in October of 1986. The data for the variables UN and INC were obtained from the Council of Economic Advisors (2009, Tables B-42, B-41). The DIS data were obtained by the University of Michigan Institute for Social Research (2009). The series adopted to measure income tax evasion, in this case represented by the variable $UAGI/RAGI = Yu/Yo$ were obtained from Feige (2009) as described in Section 1. For the interested reader, descriptive statistics for each of the variables in each of the three study periods are found in Table 1.

The P - P (Phillips-Perron) and ADF (Augmented Dickey-Fuller) unit root tests indicate that the variables $UAGI/RAGI$, INC , and DIS are stationary only in first differences, whereas the variables UN and $AUDIT$ are stationary only in second differences. Finally, variable AET is stationary in levels. This stationarity pattern holds for all three study periods. The variables DIS and $AUDIT$ are lagged two periods to adjust for multicollinearity.

For the three OLS estimates of equation (12), the Newey-West heteroskedasticity correction is adopted. The findings of these estimations are provided in Table 2. In these estimates, all 18 of the estimated coefficients exhibit the expected signs. Furthermore, ten of these estimated coefficients are statistically significant at the one percent level, two are statistically significant at the 2.5 percent level, and three are statistically significant at the five percent level. Only the coefficients

for the *AUDIT* variable fail to be statistically significant at the five percent level, although all three of these coefficients exhibit the expected negative sign and are statistically significant at approximately the ten percent level.

According to the results provided in Table 2, the coefficient on the average effective federal income tax variable (*AET*) is positive in all three estimates and statistically significant for the overall study period (1960-2008) at beyond the five percent level and statistically significant at the one percent level for the two sub-periods (1970-2008 and 1980-2008). Thus, as expected, the higher the average effective federal income tax rate, the greater the expected benefits of tax evasion may be and hence the greater the extent of that income tax evasion. This finding is consistent with most previous studies of income tax evasion using official data [Ali, Ceceil and Knoblett, 2001; Cebula, 2004; Clotfelter, 1983; Feige, 1994; Klepper, Nagin and Spurr, 1991; Tanzi, 1982, 1983].

Consistent with the arguments in Musgrave (1987) and findings in Cebula, Coombs, and Yang (2009), while reflecting the arguments in Slemrod (1992) in how the *TRA* dummy variable is specified, the results for all three study periods are compelling. In particular, all three estimated coefficients are negative and statistically significant at the one percent level; in addition, the magnitudes of the three coefficients are quite similar. In any case, in all three estimates, the implementation of the Tax Reform Act of 1986 is shown to have reduced federal personal income tax evasion in the U.S., albeit only briefly. Given the specification of *TRA* as applying to the short-term period of just 1986 and 1987, these results would seem to confirm the argument by Slemrod (1992, p. 45), who argues that it would take at least some time for taxpayers "...to learn about and adjust to the new law [the *TRA*]."

The estimated coefficients on the unemployment variable are all positive, as hypothesized, and statistically significant at beyond the five percent level in two cases (1960-2008 and 1980-2008) and statistically significant at the one percent level in one case (1970-2008). Thus, there is strong evidence that the higher the unemployment rate, the greater the extent of aggregate federal income tax evasion. This finding is compatible with the recent findings in Alm and Yunus (2009).

Next, the estimated coefficients on the per capita real GDP variable (*INC*) are all positive, as hypothesized, with two being statistically significant at the one percent level (for the periods 1970-2008 and 1980-2008) and one being statistically significant at the 2.5 percent level (for the period 1960-2008). These findings appear to confirm our hypothesis that the degree of aggregate federal

personal income taxation is greater at higher levels of taxable income. In other words, the higher the real income level (*INC*), the greater the degree to which tax evasion is expected to occur, *ceteris paribus*, plausibly because higher income persons will tend to have greater access to and knowledge of ways in which to avoid income taxes. For example, many higher income persons report income on a Schedule C, which often-times provide an opportunity to under-report income or over-report expenses (Ali, Cecil, and Knoblett, 2001). In addition, higher income persons also may have greater access to specialized tax lawyers and accountants [as well, perhaps, as a former IRS agents] who may enlighten them as to how to more efficiently both avoid and evade tax liabilities.

The estimated coefficients on the public dissatisfaction with government variable, *DIS*, are all positive, as expected, with two statistically significant at the one percent level (for 1970-2008 and 1980-2008) and one significant at the 2.5 percent level (1960-2008). Thus, as suggested by Feige (1994), it appears that the greater the degree to which the public is dissatisfied with government, the greater the secondary gains from income tax evasion and the greater the actual aggregate degree of income tax evasion.

Finally, there is the audit variable. In all three estimates it exhibits the expected negative sign; however, in all three estimates it fails to be statistically significant at the five percent level. Indeed, these three coefficients are statistically significant at barely the ten percent level. Thus, it appears that the audit rate (*AUDIT*) variable, of and in itself, may not be viewed as a strong deterrent to federal personal income taxation. This finding is consistent with previous studies such as Cebula (2001), who suggests that IRS penalties and interest charges, as well as improving income-detection technology, are more important tax-evasion disincentives. Unfortunately, dependable official data on the latter two factors are unavailable for the entirety of the study periods considered in this study.

4. Summary and Conclusions

This empirical study employs a modified version of Feige's (1989) general currency ratio model (GCM) to obtain a time series estimate of income tax evasion in the U.S. from 1940- 2008. The modifications address three germane critiques of the commonly used currency ratio models. First, the model typically requires arbitrarily choosing of a year in which the "underground economy" or tax evasion was nonexistent. Second, the model typically employs aggregate currency

holdings although it is understood that only domestic currency holdings are relevant for domestic tax evasion behavior. This critique is particularly pertinent for the U.S. since the dollar is known to be an internationally held currency. Finally, as pointed out by Garcia (1978), the model typically assumes that the ratio of currency to demand deposits is affected only by changes in tax evasion whereas financial innovations independent of noncompliance behaviors can significantly reduce demand deposit holdings and hence affect the currency ratio.

The modified currency ratio model relaxes each of the forgoing restrictions in order to obtain an aggregate time series estimate of the ratio (Y_u/Y_o) of unreported income (Y_u) to reported income ($Y_o = \text{AGI}$) as well as an estimate of the U.S. tax gap. First, we drop the common assumption that in some particular year (typically 1940) tax evasion was zero and instead employ what are regarded to be the best available benchmark estimates of tax evasion. These are the TCMP based IRS estimate for the year 1988 and the more recent 2005 NPR based IRS estimate. Second, instead of assuming that the temporal pattern of evasion is directly related to the ratio of aggregate currency to demand deposits, we take account of Feige's (2009) new estimates of overseas dollar holdings and derive estimates of the temporal pattern of domestic U.S. currency holdings. Finally, we take into account financial innovations (sweep accounts) that affect the size of demand deposit holdings over time independent of changes in noncompliance behavior. Employing the ratio of *domestic* currency holdings to demand deposits adjusted for the innovation of sweep accounts and anchoring evasion estimates to highly respected IRS benchmarks leads to improved estimates of tax evasion over time.

The new estimates of noncompliance suggest that between 18-19 percent of total reportable income is not properly reported to the IRS. The estimated \$2 trillion of unreported income gives rise to an annual tax gap of \$450-500 billion. These estimates are then employed in conjunction with variables believed to affect noncompliance behaviors to investigate the determinants of federal tax evasion behavior in the U.S. for the time period 1960-2008, as well as two sub-periods thereof, 1970-2008 and 1980-2008. The principal conclusions include the following: federal income tax evasion is an increasing function of the average effective federal income tax rate, the percentage unemployment rate of the civilian labor force, per capita real GDP, and the public's dissatisfaction with government. The study also finds that the Tax Reform Act of 1986 acted to briefly discourage/diminish aggregate personal income tax evasion, whereas the IRS audit rate may have

modestly acted to discourage that tax evasion, although this finding is un-compelling in all three of the estimates.

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Table 1. Descriptive Statistics

Variable	Mean	Standard Deviation
Period: 1960-2008:		
<i>(UAGI/RAGI)</i>	19.17	2.93
<i>AET</i>	13.83	1.086
<i>TRA</i>	0.0408	0.19999
<i>UN</i>	5.856	1.401
<i>INC</i>	25437	7326
<i>DIS</i>	0.0361	0.969
<i>AUDIT</i>	2.0529	1.458
Period: 1970-2008:		
<i>(UAGI/RAGI)</i>	20.159	2.423
<i>AET</i>	13.989	1.087
<i>TRA</i>	0.0513	0.2235
<i>UN</i>	6.132	1.35
<i>INC</i>	27833	6180
<i>DIS</i>	0.43	0.63
<i>AUDIT</i>	1.362	0.54
Period: 1980-2008:		
<i>(UAGI/RAGI)</i>	20.86	2.1414
<i>AET</i>	13.934	1.21
<i>TRA</i>	0.07	0.258
<i>UN</i>	6.103	1.42
<i>INC</i>	30353	5046
<i>DIS</i>	0.387	0.651
<i>AUDIT</i>	1.12	0.374

Table 2. Three Estimates (Dependent Variable: ($\Delta UAGI/RAGI$))

Variable\Estimation	1960-2008	1970-2008	1980-2008
a_0	-3.61	-3.74	-4.135
AET	0.236* (2.18)	0.228*** (2.96)	0.2446*** (3.05)
TRA	-3.22*** (-11.82)	-2.91*** (-11.57)	-3.02*** (-9.07)
$\Delta\Delta UN$	0.289* (2.06)	0.338*** (2.98)	0.426* (2.35)
ΔINC	0.00122** (2.48)	0.00166*** (3.61)	0.00195*** (3.95)
ΔDIS	0.951** (2.42)	1.529*** (3.71)	1.392*** (2.90)
$\Delta\Delta AUDIT$	-0.032# (-1.68)	-0.0828# (-1.69)	-0.0949# (-1.75)
R^2	0.37	0.48	0.53
Adj R^2	0.27	0.38	0.40
F	3.76***	4.84***	4.12***
DW	1.90	2.07	2.21
Rho	0.05	-0.035	-0.11

***indicates statistical significance at the one percent level; **indicates statistical significance at the 2.5 percent level; *indicates statistical significance at the five percent level; # indicates statistically significant at the ten percent level. Terms in parentheses are t-values. Δ is the first differences operator; and $\Delta\Delta$ is the second differences operator.