Online Appendix

# Tax News Shocks and Consumption

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## A The Marginal Investor: Data

The *Survey of Consumer Finances (SCF)*, which is provided by the *Board of Governors of the Federal Reserve System*, is conducted every three years and is the most comprehensive source of household wealth in the U.S. The survey has a two sample design; the first sample is a standard geographically based random sample of households, while the second supplemental sample is selected to disproportionately include wealthy families. Therefore, the choice of sampling weights is important to infer population parameters. However, the SCF supplies alternative sets of sampling weights in some years. In choosing the sampling weights I follow Wolff (2010) who minimizes the discrepancy between national balance sheet totals derived from the SCF and corresponding values from the Federal Reserve Board Flow of Funds. For the 1983 SCF I use the 'Full Sample 1983 Composite Weights' (b3005) and for the 1989 SCF I use the average of the SRC-Design-S1 series (x40131) and the SRC design-based weights (x40125). From 1995 on I use the design-based weights (x42000 for 1995 and x42001 from 1998 on) which is a partially design-based weight constructed on the basis of original selection probabilities and frame information, adjusted for non-response. In the case of the 1992 SCF, these weights produce major anomalies in the size distribution of income for 1991. As a result, I modify the weights to conform to the size distribution of income as reported in the IRS Statistics of Income and as recommended by Wolff (2010). In particular, I adjust the 1992 weights to conform to the 1989 weighting scheme. The adjustment factors for the 1992 weights are given by the inverse of the normalized ratio of weights between 1992 and 1989 and shown in the following table.

| Adjusted Gross Income (AGI) in 1989 | Adjustment Factors for 1992 Weights |
|---|---|
| $AGI < 200,000$ | 0.992 |
| $200,000 \leq AGI < 1,000,000$ | 1.459 |
| $1,000,000 \leq AGI < 4,000,000$ | 1.877 |
| $4,000,000 \leq AGI < 7,000,000$ | 4.844 |
| $AGI \geq 7,000,000$ | 12.258 |

Bonds include direct and indirect holdings, and whenever possible I use market values of bonds and face values otherwise. Direct ownership of taxable bonds includes 'face amount of other taxable/corporate bonds and foreign bonds' (b3461,x3912), 'market or face value of Treasury bonds' (b3459, x3908, x7636), 'market or face value of mortgage-backed bonds' (x3906, x7635), 'market value of other taxable bonds' (x7639), 'market value of foreign bonds' (x7638), and 'market value of all bonds not listed otherwise' (x6706). Indirect holdings of taxable debt include 'dollar amount of shares in taxable mutual funds' (b3464), 'market value of Treasury bond mutual funds' (x3826), and 'market value of other taxable bond mutual funds' (x3828). Direct ownership of tax-exempt bonds includes 'market or face value of tax-free bonds' (b3460, x3910, x7637). Indirect holdings of tax-exempt debt includes 'dollar amount of shares in tax-free mutual funds' (b3463) and 'market value of tax-free bond mutual funds' (x3824).

# B Bond Defaults

## B.1 The Markets for Treasury and Municipal Bonds

Both the Treasury and municipal bond markets are deep. During the period 1980 to 2001, Treasury debt has a share between 16% and 32% of all outstanding U.S. marketable debt while the share of municipal debt is between 9% and 19%. To put these numbers in perspective, the total volume of marketable US debt was $18.5 trillion in 2001.[1]

## B.2 Historical Bond Default Rates

Table 1 provides historical default rates for municipal bonds by credit rating. Corporate bond default rates are shown for the sake of comparison. Two facts stand out: first, AAA rated municipal debt is indeed essentially default-risk free; and second, the credit ratings for municipal and corporate bonds are not comparable. For instance, municipal bonds that are rated only BBB have a lower in-sample default rate than AAA rated corporate bonds. The two rating scales are therefore not comparable.

[1] These calculations are based on data from the Securities Industry and Financial Markets Association (SIFMA), http://www.sifma.org/research/statistics.aspx.

# C Robust Inverse

The solution to the constrained least squares problem of the inverse mapping $\beta = \mathbb{E}[W_t](\mathbb{E}[\tau|\text{Bush}] - \mathbb{E}[\tau|\text{Gore}])$ is

$$\begin{aligned} \mathbb{E}[\tau|\Delta\text{Bush}] &= \arg\min_x \left\{ ||\mathbb{E}[W_t]x - \hat{\beta}||^2 \;:\; ||\partial x||^2 \leq \varepsilon \right\} \\ &= \left(\mathbb{E}[W_t]'\mathbb{E}[W_t] + \mu\, \partial'\partial\right)^{-1} \mathbb{E}[W_t]'\hat{\beta}. \end{aligned} \tag{1}$$

$\partial$ is either the identity matrix (basic ridge regression) or the $(M-1)$-by-$M$ first difference operator (first-order ridge regression). Similarly, the ridge regression to the inverse problem $\tilde{\theta}_t = W_t \mathbb{E}_t \tau - \Lambda_t$ is

$$\begin{aligned} \mathbb{E}_t\tau &= \arg\min_x \left\{ ||W_t x - (\tilde{\theta}_t + \mathbb{E}[\Lambda_t])||^2 \;:\; ||\partial x||^2 \leq \varepsilon \right\} \\ &= \left(W_t' W_t + \mu\, \partial'\partial\right)^{-1} W_t(\tilde{\theta}_t + \mathbb{E}[\Lambda_t]) \ . \end{aligned} \tag{2}$$

To obtain a better intuition of how the regularization works it is useful to analyze the solution using the generalized singular value decomposition. Since $\mathbb{E}_t[W_t]$ and $\partial$ have full rank and the null spaces of both matrices intersect only at the zero vector, there exist matrices $U, V, \Pi, \Xi, Y$ such that $U$ is orthonormal, $Y$ is nonsingular, $\Pi$ is diagonal with decreasing diagonal elements $1 \geq \pi_i \geq \ldots \geq \pi_m \geq 0$, and $\Xi$ is diagonal with increasing elements $0 < \xi_1 \leq \ldots \leq \xi_M \leq 1$ (see Aster, Brochers, and Thurber (2005)). $\xi_m$ and $\pi_m$ are normalized such that $\xi_m^2 + \pi_m^2 = 1 \;\forall\; m$. The generalized singular values are defined as $\gamma_m = \frac{\pi_m}{\xi_m}$. The matrices $U, V, \Pi, \Xi, Y$ are related to the *two* matrices $\mathbb{E}_t[W_t]$ and $\partial$ (hence the name *generalized* singular value decomposition) as follows:

$$\mathbb{E}_t[W_t] = U \begin{bmatrix} \Pi & 0 \\ 0 & I \end{bmatrix} Y^{-1} \ ,$$

$$\partial = V \; [\Xi \;\; 0] \; Y^{-1} \ ,$$

$$(\mathbb{E}_t[W_t]Y)' \, (\mathbb{E}_t[W_t]Y) = \begin{bmatrix} \Pi^2 & 0 \\ 0 & I \end{bmatrix} \ ,$$

$$(\partial Y)' \, (\partial Y) = \begin{bmatrix} \Xi^2 & 0 \\ 0 & 0 \end{bmatrix} \ .$$

One can show that the robust inverse solution $\mathbb{E}_t\tau$ can be written as

$$\mathbb{E}_t\tau = \sum_{m=1}^{M} \underbrace{\frac{\gamma_m^2}{\gamma_m^2 + \mu}}_{\text{filter } f_m} \underbrace{\frac{u_m'(\tilde{\theta}_t + \mathbb{E}[\Lambda_t])}{\pi_m} y_m}_{\text{direct inverse}} \ , \tag{3}$$

where $u_m$ is the $m$-th column vector of matrix $U$ and $y_m$ is the $m$-th column vector of matrix $Y$. There are two important facts to take away from this equation. First, the fraction $f_m = \gamma_m^2/(\gamma_m^2+\mu)$ is a filter factor that stabilizes the inverse solution. Small singular values $\pi_m$ and hence small generalized singular values $\gamma_m$ are dampened ($f_m \ll 1$) while large singular values are less affected ($f_m \approx 1$). If $\mu = 0$, then $f_m = 1 \; \forall \; m$ and equation (3) reduces to the direct inverse (respectively to the singular value decomposition of the inverse of $\mathbb{E}_t[W_t]$). Second, since $\mathbb{E}_t[W_t]$ is a lower triangular weighting matrix, the generalized singular values are naturally decreasing in the maturity $m$, i.e. they are decreasing in $m$ without having to rearrange the columns or rows of $\mathbb{E}_t[W_t]$. Moreover, for maturities up to around 10 years, $\gamma^2 \gg \mu$ and hence $f \approx 1$. Therefore, the regularization affects the solution $\mathbb{E}_t\tau$ only for larger maturities and longer forecasting horizons.

Note that the value of $\mu$ does not substantially affect the size of the tax news shocks over reasonable ranges. This robustness is due to the fact that computing the expected after-tax lifetime income over 30 years does smooth much of the 'excess volatility' of $\mathbb{E}_t\tau$ caused by the ill-posed inverse problem. Moreover, the forward tax rates that are affected the most by the choice of $\mu$ are long-run forecasts. These expected long-run tax rates receive much less weight in the calculation of the expected after-tax lifetime income, which is an annuity value and hence discounts more distant values more heavily.

There are two main criteria in the literature for choosing $\mu$. The first is a heuristic, but more robust criterion called the L-curve approach. The other is based on generalized cross validation (GCV). GCV has a number of desirable statistical properties if the error term is independently and identically distributed, but tends to under-smooth if errors are correlated. Liquidity shocks are not uncorrelated across maturities. A liquidity shock that affects for example the 20-year maturity also affects the maturities at 19 and 21 years. Otherwise, there would be opportunities for maturity-based arbitrage. The L-curve approach on the other hand is not guaranteed to converge and is computationally expensive. I therefore calculate the optimal $\mu$ for a number of periods using both approaches. The optimal $\mu$ is on average about 0.01 for these dates and does not vary much. Hence, I set $\mu = 0.01$ globally to calculate $\mathbb{E}_t\tau$ for the entire sample from 1977 to 2001. Moreover, I use a separate optimal $\mu$ for the two election periods to calculate $\mathbb{E}[\tau|\Delta\text{Bush}]$ and $\mathbb{E}[\tau|\Delta\text{Clinton}]$ since the inversion problem of the regression coefficients has different statistical properties and hence a different optimal value of $\mu$.

# D A Model of the Consumption Response to Tax News

With quadratic preferences, a constant interest rate $r$ equal to the rate of time preference, and household wealth evolving as $A_t = (1+r)(A_{t-1}+Y_{t-1}-C_{t-1})$, consumption changes can be written in closed form as

$$C_{it} - C_{i,t-1} = \sum_{s=1}^{H-t} w_s(\mathbb{E}_t - \mathbb{E}_{t-1})(Y_{i,t+s} - T_{i,t+s}).$$

$Y$ is income before taxes $T$, and the annuity weights are given by $w_s = \frac{r}{1+r}[1 - \frac{1}{(1+r)^{H-t+1}}]^{-1}(1+r)^{-s}$. Following Campbell and Deaton (1989), I normalize consumption changes by (taxable) income, thereby expressing tax liabilities as average tax rates and making the model scale independent, a particularly useful feature when working with micro data. Specifically, I divide by predetermined adjusted gross income $Y_i^{lagged}$ asked in the first interview, thereby avoiding the endogeneity that would arise if we used current or future income, i.e., income asked in the last interview.[2] Section 4 shows similar results when using lagged consumption (appropriately rescaled) as a normalization of consumption changes.

To bring the model more closely to the data, I replace the constant annuity weights with the weights based on real after-tax discount factors used in the previous section, and I limit the household's planning horizon $H$ to the maximum available maturity $M$ (usually 30 years),

$$\Delta \ln(c_{it}) \approx \frac{C_{it} - C_{i,t-1}}{Y_i^{lagged}} \approx -\sum_{s=1}^{M} w_{t,s}^{(M)} (\mathbb{E}_t - \mathbb{E}_{t-1}) \bar{\tau}_{i,t+s} + \varepsilon_{it}^c. \tag{4}$$

To a first-order approximation, changes in expected *average* tax rates determine the growth rate of consumption. Moreover, the tax news shock has a natural interpretation: It is the change in the expected annuity value of average tax liabilities, which is the permanent component of expected future tax changes. The error term $\varepsilon^c$ contains measurement error in consumption growth as well as other economic shocks such as unanticipated changes in income or news about future income growth and any other shocks that the model ignores and for which I proxy with observable covariates in the empirical analysis.

**From expected top marginal rates to expected average rates:** To go from the observed expected top marginal tax rates to the unobserved expected average tax rates I have to make two assumptions. First, I assume that changes in the tax base—if they do occur—are perfectly foreseen. With the exception of the Tax Reform Act of 1986 (TRA), which is I discuss in more detail in Online Appendix D, this assumption is reasonable for the income tax reforms in my sample because the brackets did not change much. Section 4.3 shows that excluding TRA from the sample by focusing on the later period starting in the mid-1990s yields similar results. Second, I scale the perfect-foresight tax rate $\tau_{t+s}(b)$ in each lower income bracket $b < B$ (where $B$ denotes the top tax bracket) by a measure of foresight implied by current expectations of future top tax rates. This measure is the ratio of the market-based expected top tax rate $\mathbb{E}_t \tau_{t+s} \equiv \mathbb{E}_t \tau_{t+s}(B)$ to the perfect-foresight top tax rate $\tau_{t+s}(B) \equiv \tau_{t+s}$, where the latter is taken from Saez (2004). We can therefore express the

[2] Note that the survey asks households only in the first and last interview about their *annual* income, while expenditures are asked in each quarterly interview for the previous three months. Hence, income asked in the first interview is fully predetermined relative to all quarterly consumption changes a household reports in subsequent interviews.

unobserved expected lower-bracket tax rates in terms of observed quantities,[3]

$$\mathbb{E}_t \tau_{t+s}(b) = \tau_{t+s}(b) \times \frac{\mathbb{E}_t \tau_{t+s}(B)}{\tau_{t+s}(B)}. \tag{5}$$

This means that if households have perfect foresight about the top marginal tax rate (i.e., if they correctly guess the future tax rate such that the second term is one), they also have perfect foresight about the lower bracket rates. Since the empirical analysis restricts the sample to higher-income households, defined as the top quartile of the income distribution for which policy-induced changes in average tax rates are highly correlated with changes in the top marginal tax rate, this assumption does not affect the results much. In the robustness section I analyze the sensitivity of the results to this assumption. First, I obtain essentially the same results when using only the smaller subset of households in the top 10% percentile who are not much affected by assumptions about expected rates in lower tax brackets, because most of their income falls into the higher brackets. Second, I show that if we instead fix the lower bracket rates at their current predetermined level based on the current tax code (i.e., if we use $\tau_t(b)$ instead of $\tau_{t+s}(b)$) I obtain very similar results. This essentially implements the Bartik approach without using the life-cycle model to derive the correct cross-sectional weights.

With these assumptions, changes in household-specific expected average tax rates can be written as

$$(\mathbb{E}_t - \mathbb{E}_{t-1})\bar{\tau}_{i,t+s} = \sum_b \frac{B_{i,t+s}(b)\tau_{t+s}(b)}{Y_{i,t+s}} \cdot \frac{(\mathbb{E}_t - \mathbb{E}_{t-1})\tau_{t+s}}{\tau_{t+s}} = \frac{\bar{\tau}_{i,t+s}}{\tau_{t+s}} \left(\mathbb{E}_t \tau_{t+s} - \mathbb{E}_{t-1}\tau_{t+s}\right),$$

where $B_{i,t+s}(b)$ is the income household $i$ receives in tax bracket $b$. The expected change in the top tax rate $(\mathbb{E}_t - \mathbb{E}_{t-1})\tau_{t+s}$, which is identified using the municipal yield spreads, can now be interpreted as the signal that the household receives between date $t-1$ and $t$. The term $\frac{\bar{\tau}_{i,t+s}}{\tau_{t+s}}$ is a measure of the relevance of the signal for the household's consumption decision. This corresponds closely to the "importance weight" $\omega_i$ in the Bartik approach described above: If this ratio is low then the impact of news about the top tax rate in $s$ years has only a small impact on the household's expected after-tax lifetime income, and a rational household should therefore largely ignore the signal. On the other hand, if the ratio is large, then the household should pay close attention to the signal.

It is important to note that this assumption does *not* imply that the expected change in the *average* tax rate is the same for all households. To see this, suppose that the expected future tax schedule in $s$ years from now has only two tax rates, 10% and 50%. Let the first tax bracket range from \$0 to \$10,000 so that all income above \$10,000, which is the second income bracket, is expected to be taxed at the 50% rate. Suppose that the expected top tax rate increases by 10%, i.e. $\frac{\Delta_t \mathbb{E}_{t+1}\tau_{t+s}(B)}{\tau_{t+s}(B)} = 0.1$ such that the lower tax rate increases by 1 percentage point from 10% to 11% and the top tax rate by 5 percentage points from 50% to 55%. The expected average tax rate of a

[3] Since the sampling frequency is quarterly at the household-level while expectations are formed over annual intervals, I assume that the perfect-foresight variables do not change between quarters, so that $(\mathbb{E}_{t+1} - \mathbb{E}_t)\tau_{t+s}(b) = \tau_{t+s}(b) \times \frac{(\mathbb{E}_{t+1} - \mathbb{E}_t)\tau_{t+s}}{\tau_{t+s}}$ .

household with an income of $10,000 increases by 1 percentage point, while the expected average tax rate of a household with an income of $15,000 increase by 2⅓ percentage points. Moreover, the expected change of the average tax rate approaches 5 percentage points as income goes to infinity, which equals the expected change of the top tax rate. Figure A2 in the online appendix shows the cross-sectional treatment heterogeneity for each tax reform in the sample. Using the NBER TAXSIM calculator, I compute perfect-foresight average tax rates $\{\bar{\tau}_{i,t+s}\}_{s=0}^{M}$ for each household $i$ in the CEX that depend on the head of household's age and the household's predetermined income percentile. These income profiles allow for predictable changes in average tax rates due to the hump shape of the life-cycle income profile and are described in more detail in the data section and the appendix.

As mentioned above, the assumption in equation (5) is least restrictive for higher-income households for which changes in the top tax rate are closely related to changes in their average tax rate. For this reason I focus on the consumption response of higher-income households to tax news. Figure 5 shows that changes in average tax rates for households in the top quartile of the adjusted gross income distribution (AGI) are highly correlated over the sample period, although they are not perfectly correlated. I therefore choose the top income quartile of households (by tax filer status and year) in the CEX as my baseline sample, and I then analyze how the results change as I change this threshold. The different income distribution cut-offs trade off measurement error with statistical power: While including more households that are further away from the top tax bracket increases the precision of the estimates, it potentially biases the results if assumption (5) is less appropriate for those additional households, i.e., if tax news shocks are less well measured with municipal yield spreads for those households.

# E Discussion of the Tax Reforms Covered by the Sample

## E.1 Average Tax Rate Changes

Figure A2 shows the changes in the average tax rate as a function of taxable income for all major income tax reforms in my sample. To generate these profiles I use a distribution of incomes with equally spaced grid points of $100 increments. I feed this income distribution into the TAXSIM calculator and assume that the households are married, file jointly, and have no children. For example, panel (a) shows the change in average tax rates caused by the first Reagan tax cut (Economic Recovery Tax Act of 1981, ERTA) as a function of taxable income. The tax cuts were phased-in over three years from 1981 to 1983. The thick black line shows the total change by comparing the average tax rate after the reform in 1984 with the average tax rate before the reform in 1980. Panel (a) emphasizes the fact that households were affected differently by the income tax changes depending on the taxable income.

The average tax rates imputed in the CEX have more variation than Figure A2 suggests. This additional variation comes from the fact that different households have different family characteristics, such as the number of children and dependents or the marital status, as well as different deductions, exemptions, and tax credits. The CEX provides a rich set of household characteristics that allows me to compute household specific tax rates. The only main input variables used by TAXSIM that are missing from the CEX are short- and long-run capital gains. The fact that changes in the average tax rate are not constant as a function of taxable income provides identifying variation in the cross-section when I control for year-by-month time fixed effects.

### E.2 Changes in the Tax Base

Tax reforms can affect not only the tax rates but also the tax base. Since the effect of a tax reform on the after-tax lifetime income is a combination of changes in the tax rates and the tax base, it is useful to analyze changes in the tax base over the sample period more closely. Most tax reforms since 1980 affected the income tax base only modestly, with the exception of the Tax Reform Act of 1986 (TRA 1986). Auerbach and Slemrod (1997) discuss this tax reform in detail, showing that the reduction in income tax revenue was compensated by widening the base of the corporate tax and closing loopholes in the tax code. Although the incidence of the corporate tax is difficult to assess, it is clear that closing tax loopholes affects mainly very high-income households, in particular those who have flexibility in changing the composition of their taxable income, such as self-employed households and business owners. The sample used in this paper excludes self-employed households and the CEX tends to under-samples very rich households. Since both groups are affected the most from the offsetting extension of the tax base, it is likely that most high- and middle-income households in the sample benefited from the tax reform, even though the TRA 1986 might have been roughly revenue neutral in the aggregate.[4] Nevertheless, since Auerbach and Slemrod conclude that "the effects of the [Tax Reform] Act on saving are more difficult to identify because of the many confounding influences of the period and our greater uncertainty about the proper modeling of the savings decision," I test the robustness of the result using different time sub-periods in the robustness section of the main paper, in particular looking at a subsample that includes only observations after the implementation of the TRA 1986.

## F Household Spending Data

This section provides more details about the household spending and income data used in the analysis. I use sample restrictions that are common in the literature; see for example, Souleles (1999) or Johnson, Parker, and Souleles (2006). In particular, I restrict the sample to households with complete income reports and non-zero income where the head's age is between 25 and 65 years and the head is not a student. In addition, I drop the following cases: interviews with more or less than three monthly observations; households with zero food or total expenditures; non-consecutive interviews; observations with negative expenditures where there should not be any; households with more than one consumer unit; households for which the family size changes by more than three;

[4] Many lower-income households faced an increase in tax liabilities as a result of the tax reform; see for example Hausman and Poterba (1987).

households for which the age of any member increases by more than one or decreases; and households with negative liquid wealth; and households with positive business or farm income. I correct sample breaks in the following few expenditure categories due to slight changes in the questionnaire: food at home (1982Q1-1988Q1), personal care services (2001Q2), occupation expenditures (2001Q2), and property taxes (1991Q1). As recommended by the BLS, I sum expenditures that occur in the same month but are reported in different interviews. Due to extreme outliers I windsorize consumption growth at the 10% level; all results are robust to choosing a different threshold.

I impute taxes with the NBER TAXSIM calculator using an iterative procedure to determine the itemization status of each household and to account for deductions that depend on the household's AGI such as health-care or job expenses. The code is available at www.nber.org/~taxsim/to-taxsim/cex-kueng/cex.do. I compute perfect-foresight average tax rates $\{\bar{\tau}_{i,t+s}\}_{s=0}^{M}$ for each household $i$ that depend on the head of household's age and the household's predetermined income percentile. These profiles allow for predictable changes in average tax rates due to the hump shape of the life-cycle income profile. Other studies also found that household income dynamics are well approximated by a random walk after controlling for the age profile of income; see e.g., Abowd and Card (1989) and Meghir and Pistaferri (2004). Predetermined income summarizes observed household characteristics such as education and experience as well as unobserved heterogeneity such as work effort. Household age has predictive power for future income even conditional on work experience. Having only two dimensions guarantees that there are at least 20 households in each age-income cell in each year.

I estimate future average tax rates non-parametrically; in particular, I discretize the joint distribution of age and income and assume that the household remains in the same age-specific income percentile throughout its life-cycle.[5] I use households age 65 to 75 to estimate counter-factual retirement income after age 65. I assume that households expect to receive this level of retirement income for the rest of the planning period. I limit the estimation of the retirement period to households between ages 65 to 75 due to the fact that the quality of the survey answers tends to be poorer for old retirees.

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[5] More precisely, I use the following income percentile thresholds: $10, 20, \ldots, 50, 55, \ldots, 95$. I use a finer grid for higher incomes to better account for the increasing income inequality during the sample period. I use age bins with a 10-year range to have at least 20 households in each cell. The five age bins 25-34, 35-44, 45-54, 55-64, 65-75 approximate the income life-cycle profiles well.

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**Table A1. Historical bond default rates 1970-2006 (in %)**

| Rating categories | Municipal Bonds | | Corporate Bonds | |
|---|---|---|---|---|
| | Moody's | S&P | Moody's | S&P |
| Aaa / AAA | 0 | 0 | 0.52 | 0.60 |
| Aa / AA | 0.06 | 0 | 0.52 | 1.50 |
| A / A | 0.03 | 0.23 | 1.29 | 2.91 |
| Baa / BBB | 0.13 | 0.32 | 4.64 | 10.29 |
| Ba / BB | 2.65 | 1.74 | 19.12 | 29.93 |
| B / B | 11.86 | 8.48 | 43.34 | 53.72 |
| Caa-C / CCC-C | 16.58 | 44.81 | 69.18 | 69.19 |
| Investment Grade | 0.07 | 0.20 | 2.09 | 4.14 |
| Non-Investment Grade | 4.29 | 7.37 | 31.37 | 42.35 |
| All | 0.10 | 0.29 | 9.70 | 12.98 |

*Source*: Moody's and S&P, taken from Representative Barney Frank's request to accompany the Municipal Bond and Fairness Act H.R. 6308, September 9 2008. The data were accessed on 4/7/2010 via http://frwebgate.access.gpo.gov.

Table A2. Personal state income taxes on interest income, 1977-2010

| Bond type: | In-state muni | Out-of-state muni | Treasury | Corporate | Max. tax rate | Period of max. tax |
|---|---|---|---|---|---|---|
| Alabama | exempt | taxable | exempt | taxable | 3.65 | 1988-90 |
| Alaska | | *no personal income tax 1979-2010* | | | 14.5 | 1977-78 |
| Arkansas | exempt | taxable | exempt | taxable | 7.43 | 2003-04 |
| Arizona | exempt | taxable | exempt | taxable | 6.74 | 1992-93 |
| California | exempt | taxable | exempt | taxable | 11.66 | 1991-95 |
| Colorado | exempt | taxable | exempt | taxable | 5.15 | 1992-98 |
| Connecticut* | exempt | taxable | exempt | taxable | 5 | 2003-10 |
| Delaware | exempt | taxable | exempt | taxable | 19.8 | 1977-78 |
| Florida | | *no personal income tax 1977-2010* | | | | |
| Georgia | exempt | taxable | exempt | taxable | 6 | 1977-86 |
| Hawaii | exempt | taxable | exempt | taxable | 10.01 | 2009 |
| Idaho | exempt | taxable | exempt | taxable | 8.28 | 1991-99 |
| Illinois | taxable | taxable | exempt | taxable | 3 | 1990-2010 |
| Indiana | exempt | exempt | exempt | taxable | 3.4 | 1988-2010 |
| Iowa | taxable | taxable | exempt | taxable | 7.39 | 1988-90 |
| Kansas | exempt | taxable | exempt | taxable | 6.91 | 1983-84 |
| Kentucky | exempt | taxable | exempt | taxable | 6.18 | 1991-2005 |
| Louisiana | exempt | taxable | exempt | taxable | 4.14 | 1988-90 |
| Maine | exempt | taxable | exempt | taxable | 10.19 | 1991-92 |
| Maryland | exempt | taxable | exempt | taxable | 7.5 | 1977-78 |
| Massachusetts* | exempt | taxable | exempt | taxable | 6.25 | 1991 |
| Michigan | exempt | taxable | exempt | taxable | 6.35 | 1983 |
| Minnesota* | exempt | taxable | exempt | taxable | 9.65 | 1983 |
| Mississippi | exempt | taxable | exempt | taxable | 5.07 | 1992-2005 |
| Missouri | exempt | taxable | exempt | taxable | 6.07 | 1994-2005 |
| Montana* | exempt | taxable | exempt | taxable | 9.02 | 1988 |
| Nebraska | exempt | taxable | exempt | taxable | 11.19 | 1977, 1979 |
| Nevada | | *no personal income tax 1977-2010* | | | | |
| New Hampshire | | *no personal income tax 1977-2010* | | | | |
| New Jersey* | exempt | taxable | exempt | taxable | 10.75 | 2009 |
| New Mexico | exempt | taxable | exempt | taxable | 8.26 | 1977-80 |
| New York* | exempt | taxable | exempt | taxable | 15 | 1977-78 |
| North Carolina | exempt | taxable | exempt | taxable | 8.5 | 2001-05 |
| North Dakota | exempt | taxable | exempt | taxable | 5.41 | 1993-2005 |
| Ohio | exempt | exempt | exempt | taxable | 9.03 | 1984 |
| Oklahoma | exempt | taxable | exempt | taxable | 6.65 | 1991-92 |
| Oregon* | exempt | taxable | exempt | taxable | 13 | 1977-78 |
| Pennsylvania* | exempt | exempt | exempt | taxable | 3.07 | 2004-10 |
| Rhode Island | exempt | taxable | exempt | taxable | 11.79 | 1983 |
| South Carolina | exempt | taxable | exempt | taxable | 7.08 | 1991-2005 |
| South Dakota | | *no personal income tax 1977-2010* | | | | |
| Tennessee | | *no personal income tax 1977-2010* | | | | |
| Texas | | *no personal income tax 1977-2010* | | | | |
| Utah | taxable | taxable | exempt | taxable | 7.75 | 1987 |
| Vermont | exempt | taxable | exempt | taxable | 14.88 | 1977-78 |
| Virginia | exempt | taxable | exempt | taxable | 5.82 | 1991-2005 |
| Washington | | *no personal income tax 1977-2010* | | | | |
| Washington D.C. | exempt | taxable | exempt | taxable | 11 | 1982-86 |
| West Virginia* | exempt | taxable | exempt | taxable | 12.7 | 1984 |
| Wisconsin* | taxable | taxable | exempt | taxable | 11 | 1983 |
| Wyoming | | *no personal income tax 1977-2010* | | | | |

*Notes:* The tax status is an update of Temel, Judy W., *The Fundamentals of Municipal Bonds*, 5 ed., John Wiley & Sons, 2001. Maximum state income tax rates 1977-2010 are based on the NBER TAXSIM calculator.
* The following states tax corporations on all interest income: Connecticut, Massachusetts, Minnesota, Montana, New Jersey, New York, and Oregon. Pennsylvania exempts corporations from all taxes on interest. West Virginia and Wisconsin tax corporations on their interest income from municipal bonds, but exempt interest from Treasury bonds.

Figure A1 – Average break-even tax premium $\mathbb{E}[\Lambda_t]$ as a function of the maturity.

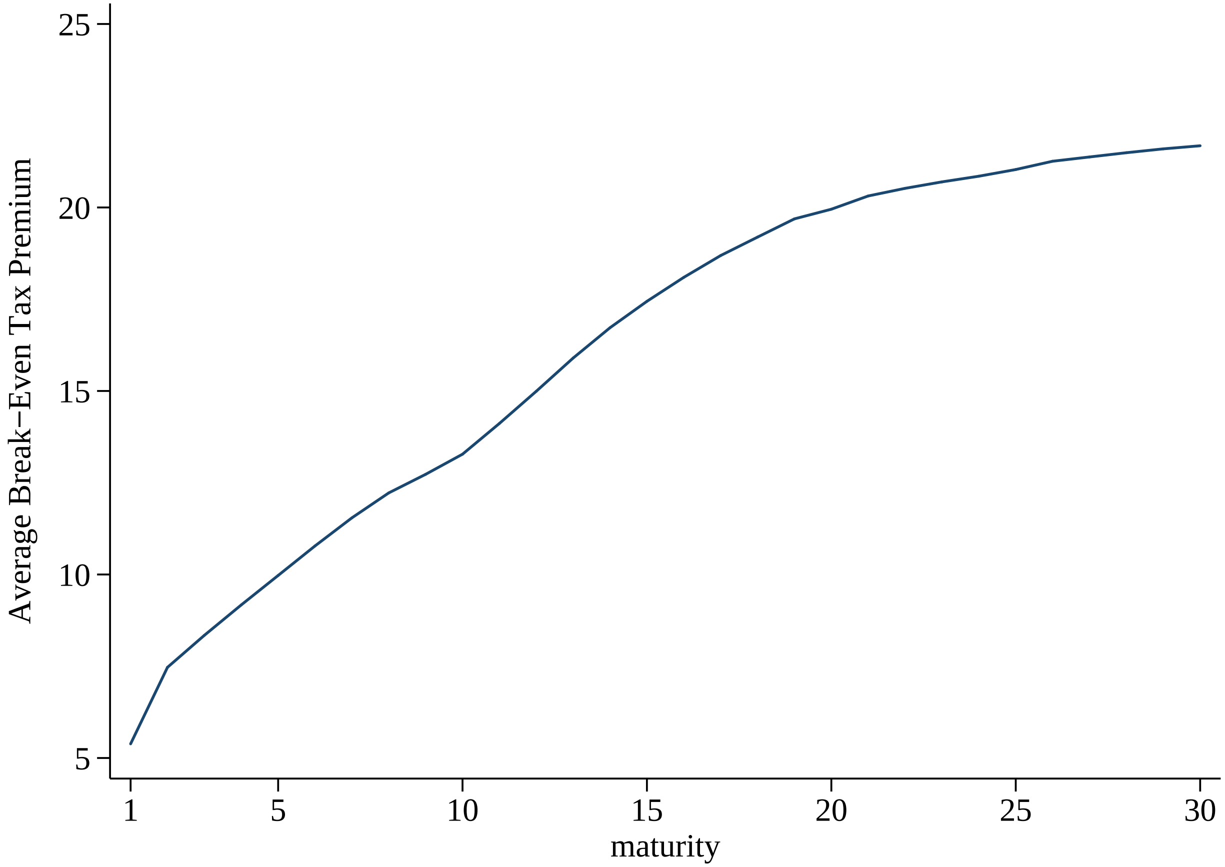
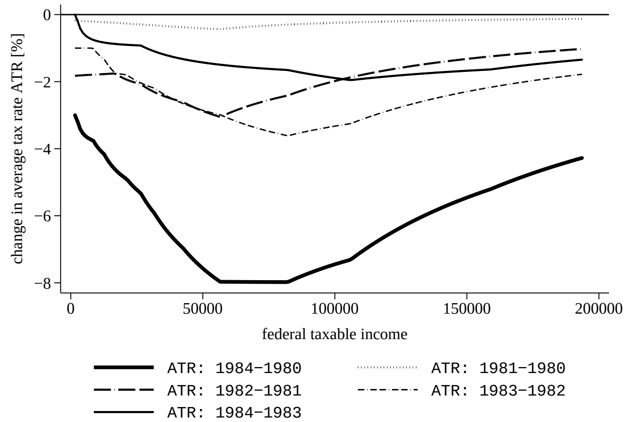
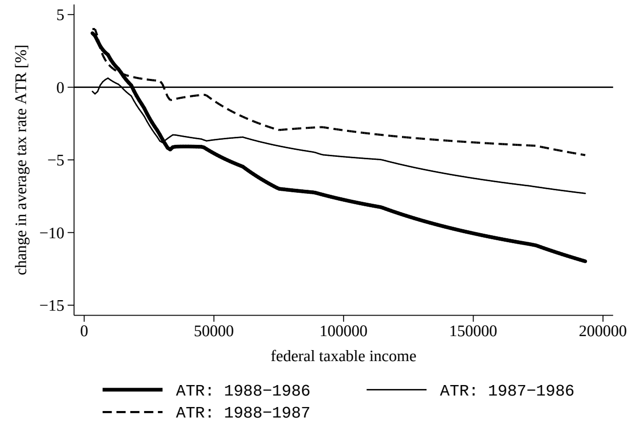


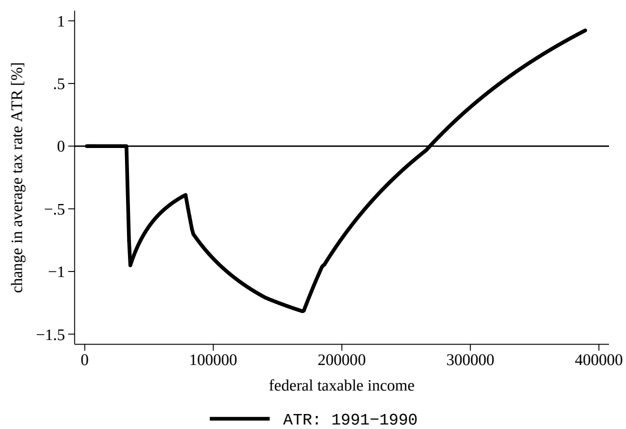
Figure A2 – Change in the average tax rate caused by income tax reforms between 1980 and 2003.



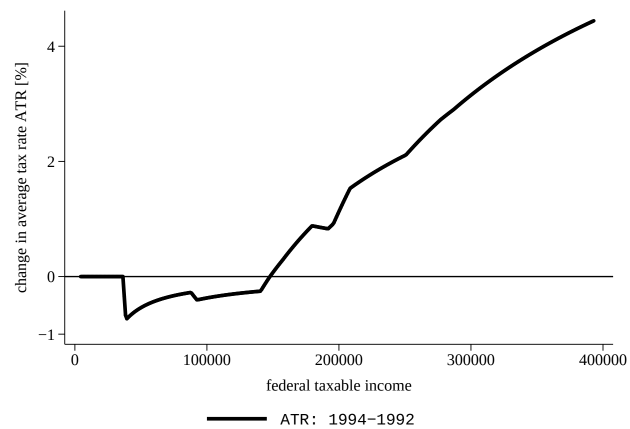

(a) ERTA 1981



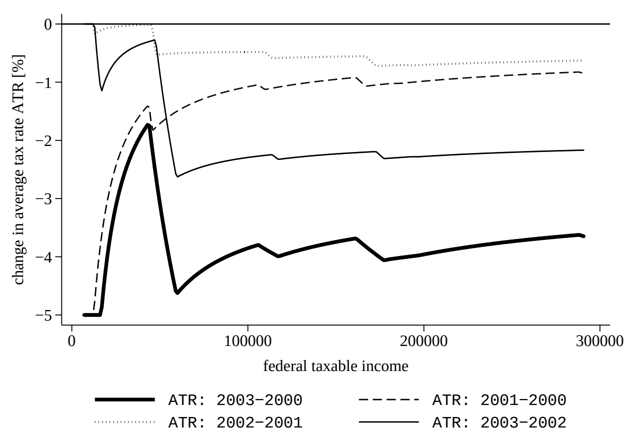

(b) TRA 1986




(c) OBRA 1990




(d) OBRA 1993




(e) EGTRRA 2001 and JGTRRA 2003

Notes: All figures were generated with the TAXSIM calculator using an income distribution with $100 increments. The tax rates are calculated for married households filing jointly and having no children.