A Proofs and derivations

Proposition 1. *In the sheltering decision problem of section 1.1, if* $m(-b^{PM}+s) = u(w - b^{PM}+s)$*, where* $u(\cdot)$ *is weakly concave and twice continuously differentiable, then* f_b *is continuous.*

Proof. Let $s^*(b^{PM}|w)$ denote the optimal sheltering solution. The assumptions that $c'(0) < u'(w - b^{PM})$ and $\lim_{s\to\infty} u'(w - b^{PM} + s) - c'(s) < 0$ imply an interior solution, determined by the first order condition $u'(w - b^{PM} + s^*(b^{PM}|w)) = c'(s^*(b^{PM}|w))$. The implicit function theorem guarantees that $s^*(b^{PM}|w)$ is continuously differentiable. As a result, we can express final balance due as a continuously differentiable function of pre-manipulation balance due: $b(b^{PM}) = b^{PM} - s^*(b^{PM}|w)$. The convexity of $c(\cdot)$ guarantees that $b(b^{PM})$ is strictly increasing, and thus invertible. Denote the inverse function as $\psi(b)$. The CDF of b may be expressed in terms of the CDF for b^{PM} by the relationship $F_b(x) = F_b^{PM}(\psi(b))$. Differentiating yeilds $f_b(x) = f_b^{PM}(\psi(b))\psi'(b)$, which expresses the PDF of b as a product of continuous functions. QED

Bunching-based bounds on excess sheltering

These calculations establish the bunching-based bounds on excess sheltering, which are reported in table 1. To simplify notation, denote the high and low sheltering amounts as $c'^{-1}(1+\eta\lambda) \equiv s^H$ and $c'^{-1}(1+\eta) \equiv s^L$.

To begin, notice that the mass present in the zero-dollar bin of the balance due histogram corresponds to $\int_{-0.5}^{0.5} f_b(x)\,dx$, the probability of balance due falling within 50 cents of zero. Expressing this value with respect to the pre-manipulation balance-due distribution, this mass is $\int_{s^L-0.5}^{s^H+0.5} f_b^{PM}(x)\,dx$, the probability of pre-manipulation balance due falling within 50 cents of the "shelter to zero" region.

Due to the assumption that f_b^{PM} is decreasing on the relevant range, it must hold that

$$f_b^{PM}(s^H + 0.5) \int_{s^L-0.5}^{s^H+0.5} dx \leq \int_{s^L-0.5}^{s^H+0.5} f_b^{PM}(x)\, dx \leq f_b^{PM}(s^L - 0.5) \int_{s^L-0.5}^{s^H+0.5} dx \tag{14}$$

$$f_b^{PM}(s^H + 0.5) \cdot \left(s^H - s^L + 1\right) \leq \int_{s^L-0.5}^{s^H+0.5} f_b^{PM}(x)\, dx \leq f_b^{PM}(s^L - 0.5) \cdot \left(s^H - s^L + 1\right) \tag{15}$$

We wish to use these inequalities to bound $s^H - s^L$, using terms from the estimated final balance-due distribution. These inequalities imply that

$$\frac{\int_{s^L-0.5}^{s^H+0.5} f_b^{PM}(x)\, dx}{f_b^{PM}(s^L - 0.5)} - 1 \leq s^H - s^L \leq \frac{\int_{s^L-0.5}^{s^H+0.5} f_b^{PM}(x)\, dx}{f_b^{PM}(s^H + 0.5)} - 1 \tag{16}$$

Let $\hat{f}(x)$ denote the estimated distribution of observed balance due, as was generated from the regression described in equation 9 and reported in table 1. Substituting the values in equation 16 with their estimated values, we arrive at

$$\frac{\hat{f}(0)}{\hat{f}(-0.5)} - 1 \leq \underbrace{s^H - s^L}_{\substack{\text{additional sheltering} \\ \text{in loss domain}}} \leq \frac{\hat{f}(0)}{\hat{f}(0.5)} - 1 \tag{17}$$

These calculations generate the upper and lower bounds reported in table 1.

Derivation of the likelihood function when excess mass is diffusely distributed

Here I present a details of the maximum likelihood estimates discussed in section 3.3 and presented in figure 5. Let $g(b|\theta)$ denote a three-component mixture of normal PDFs, assumed to have a common mean to preserve symmetry. $G(b|\theta)$ denotes the CDF. θ is a parameter vector containing the relevant model components: the common mean, the standard deviations, and the mixing probabilities. The shifting parameter $\tilde{s}$ is not included in this vector, and will be chosen endogenously to rationalize the excess mass near zero. All such excess mass is assumed to fall within range $\left[-\frac{w}{2}, +\frac{w}{2}\right]$. Using this mixture distribution to fit f_b^{PM}, and applying the results of proposition 3, the likelihood of a given observation—conditional on being outside of the range $\left[-\frac{w}{2}, +\frac{w}{2}\right]$, where the likelihood is unknown—is:

$$\mathcal{L}(b_i|\theta) = \begin{cases} g(b_i|\theta) & \text{if } b_i < -\frac{w}{2} \\ g(b_i + \tilde{s}|\theta) & \text{if } b_i > \frac{w}{2} \end{cases} \tag{18}$$

To rationalize the empirical mass found in $\left[-\frac{w}{2}, +\frac{w}{2}\right]$, $\tilde{s}$ must satisfy:

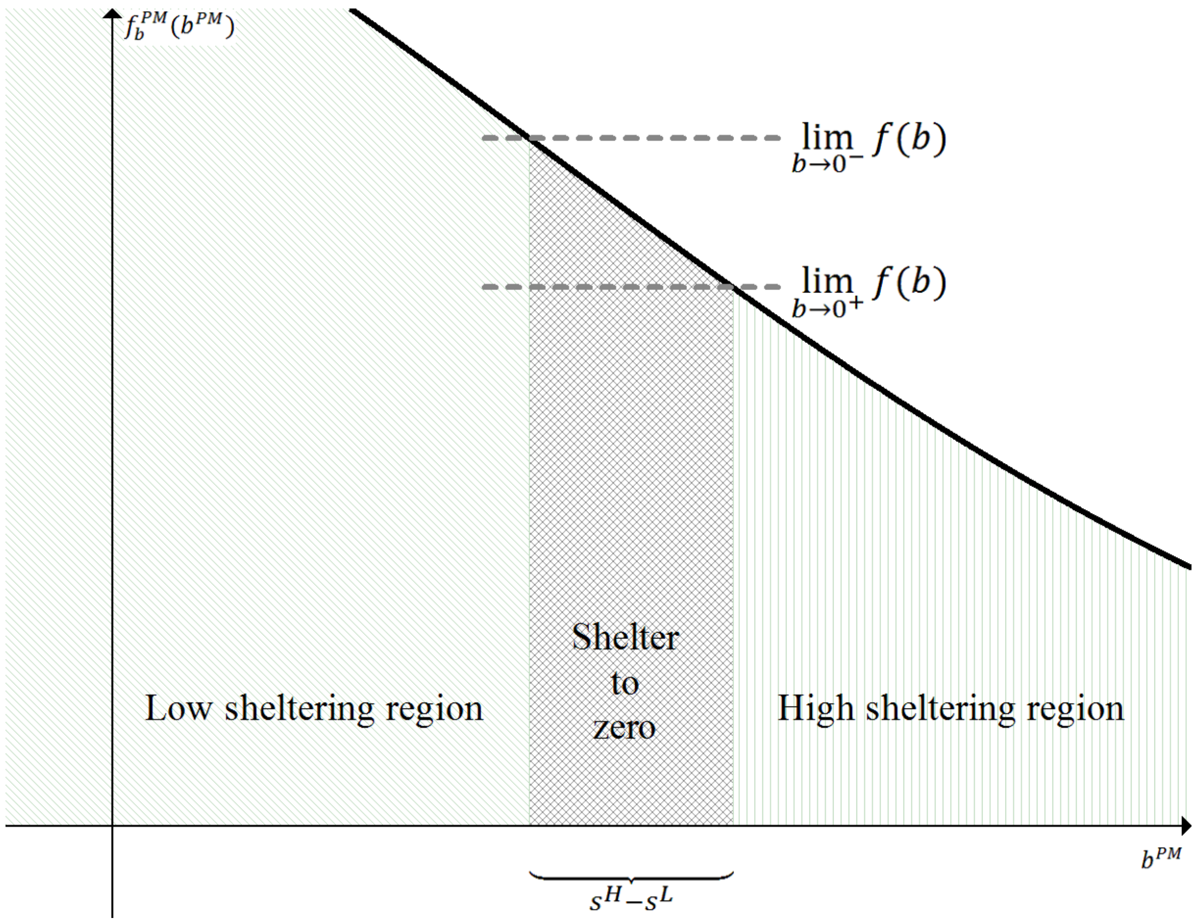
$$\sum_{i=1}^{N} \frac{I(b_i \in \left[-\frac{w}{2}, +\frac{w}{2}\right])}{N} = G\left(\frac{w}{2} + \tilde{s}\middle|\theta\right) - G\left(\frac{-w}{2}\middle|\theta\right) \tag{19}$$

$$\rightarrow \tilde{s} = G^{-1}\left(\sum_{i=1}^{N} \frac{I(b_i \in \left[-\frac{w}{2}, +\frac{w}{2}\right])}{N} + G\left(\frac{-w}{2}\middle|\theta\right)\middle|\theta\right) - \frac{w}{2} \tag{20}$$

While an analytic equation for G^{-1} is not available, the solution to equation 20 can be solved numerically. The numerical solution is generated with Newton's method, with tolerance set to 0.001. With the resulting endogenous specification of $\tilde{s}$, the log-likelihood function implied by equation 18 is maximized to produce the estimated model.

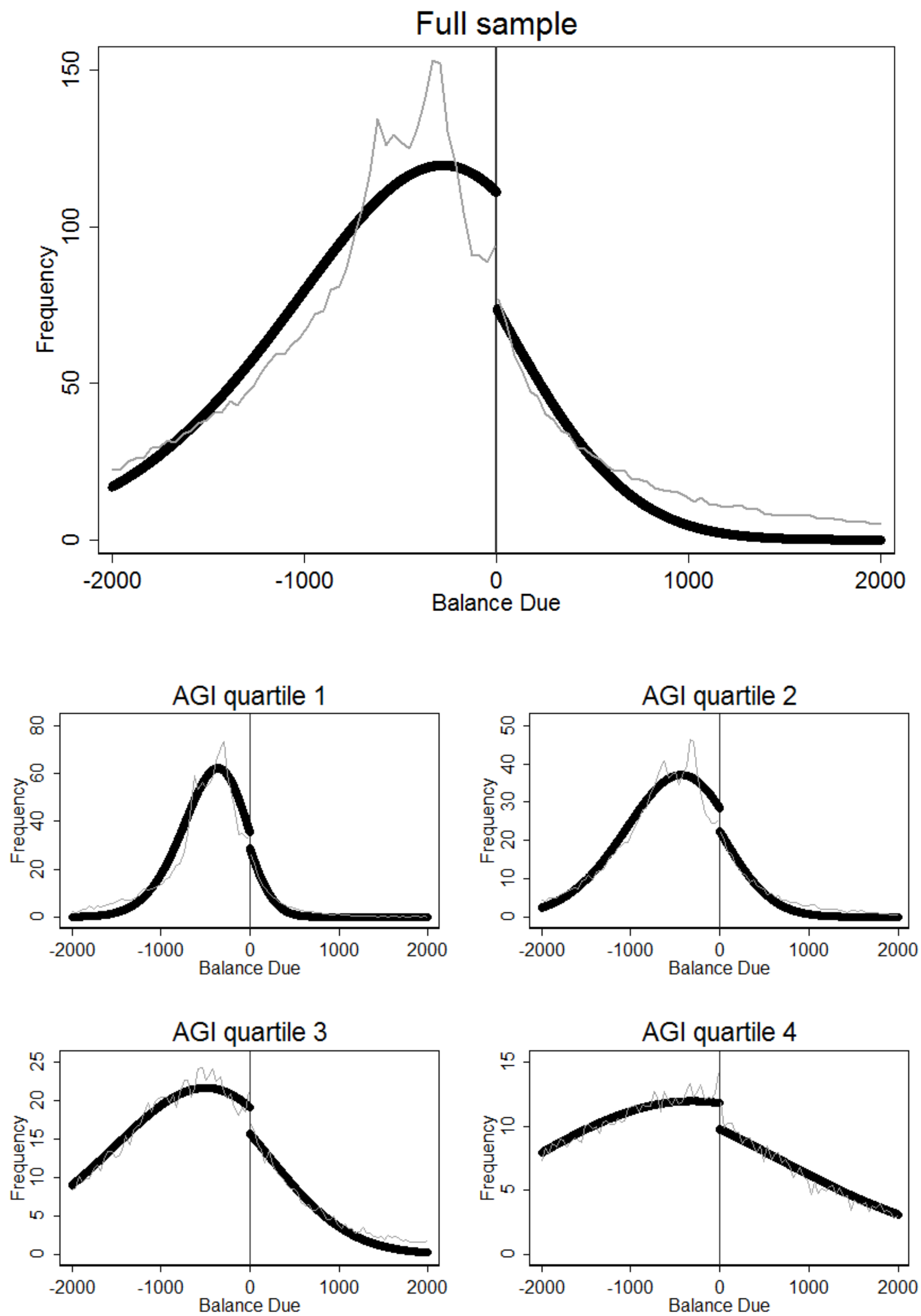
B Supplemental tables and figures

Figure A.1: Bounds on integral of "shelter to zero" region



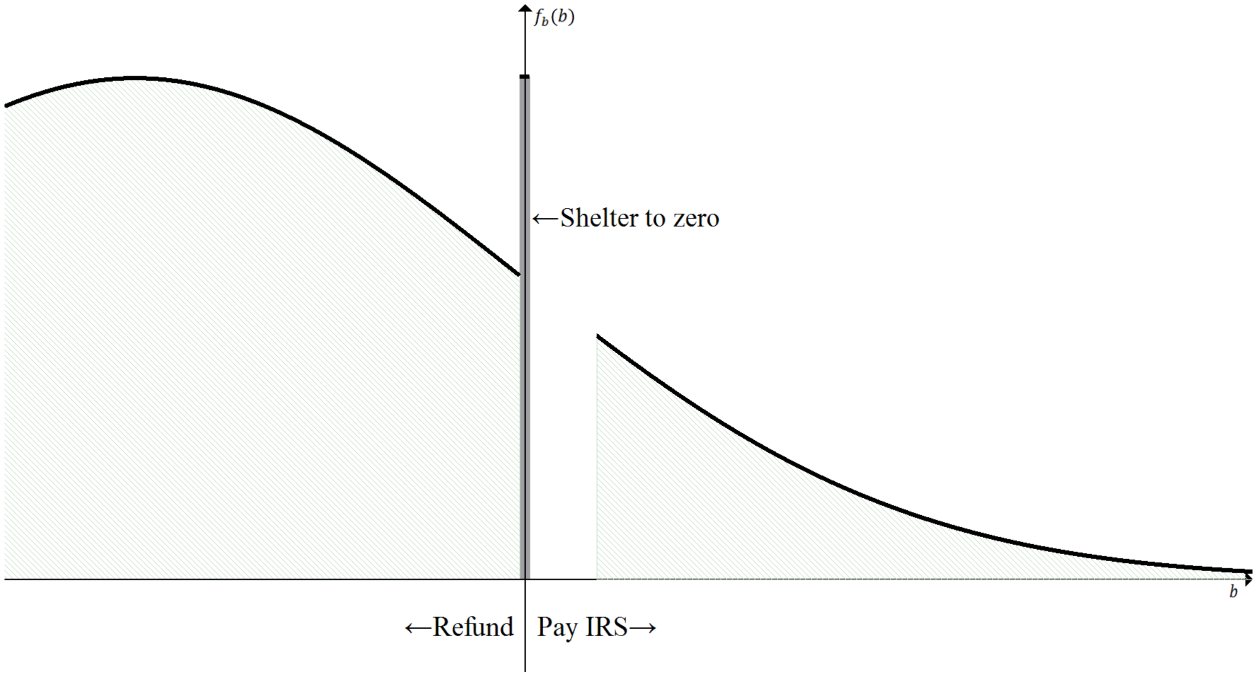
Notes: This figure presents the hypothetical distribution previously presented in figure 1, zoomed on the "shelter to zero" region. Under the assumption that the distribution is decreasing over these values, the integral of the "shelter to zero" region can be no larger than the width of the region times the density on the left, and no smaller than the width of the region times the density on the right.

Figure A.2: Fit of predicted skew-normal distributions



Notes: Plots of distributions fitted to the balance due frequency histogram. Balance due expressed in 1990 dollars, and rounded to $1 bins. Grey lines indicate the estimated models from table A.5, fitting a skew-normal distribution with a shift in the loss domain. For comparison, black lines indicate local-average kernel regressions (bandwidth: 10, kernel: Epanechnikov). Range of plot restricted to $[-2000, 2000]$, with zero excluded.

Figure A.3: Distribution with fixed cost at zero balance due



Notes: This figure presents a hypothetical distribution that could be generated if fixed costs were incurred in the loss domain. A fixed cost associated with positive balance due generates a region, $[0, b^{max}]$, where the taxpayer shelters to zero to avoid the fixed cost. Outside of this region, decisions are made according to marginal incentives, as they would be in the absence of the fixed cost. Similar to the model with loss aversion (illustrated in figure 1), fixed costs generate excess mass at zero. In contrast to the model with loss aversion, fixed costs do not shift the entire loss domain, and furthemore generate a region of missing mass.

Table A.1: Sample size across SSN codes and model years

	SSN Code			
	A	B	C, D, E	Total
1979	8852	9013	26935	44800
1980	9107	9205	27709	46021
1981	9131	9282	27825	46238
1982	9129	0	0	9129
1983	9389	9514	0	18903
1984	9636	0	0	9636
1985	9948	10013	0	19961
1986	9990	0	0	9990
1987	10362	10543	0	20905
1988	10627	10707	0	21334
1989	10952	11054	0	22006
1990	11122	11230	0	22352
Total	118245	90561	82469	291275
Unique Taxpayers	15950	15919	32158	64027

Notes: This table presents the number of responses over time by different SSN groups. Five randomly determined four-digit SSN endings were chosen to form the sample, labeled A-E. Group A was sampled from 1979-1990. Group B was not sampled in 1982, 1984, or 1986. Groups C, D, and E were sampled only for the first three years of the data collection.

Table A.2: Summary statistics

	Mean	Standard Deviation	p5	p25	p50	p75	p95
Balance Due	-523	3287	-3202	-1170	-521	-56	1988
Taxes (Before Credits)	4595	6868	166	1084	2687	5633	14409
Payments	5147	6738	445	1508	3318	6556	14784
Adjusted Gross Income	32631	26112	6865	15100	26124	42702	77473
Filed 1040	0.66						
Filed 1040A	0.26						
Filed 1040EZ	0.08						
Observations	229116						
Unique Taxpayers	53177						

Notes: Mean, standard deviation, and quantiles of variables relevant for the balance due calculation. Monetary amounts expressed in 1990 dollars.

Table A.3: Estimates of excess mass at zero balance due, alternative standard errors

	(1) All AGI groups	(2) 1st AGI quartile	(3) 2nd AGI quartile	(4) 3rd AGI quartile	(5) 4th AGI quartile
γ: I(balance due $= 0$)	136.43***	46.57***	26.79***	21.06***	42.01***
	(15.64)	(9.12)	(7.46)	(6.77)	(7.73)
δ : I(balance due > 0)	-16.26***	-3.50	-4.20	-3.42	-5.14**
	(5.13)	(3.03)	(2.74)	(2.43)	(2.06)
α : Constant	99.57***	33.43***	27.21***	21.94***	16.99***
	(2.90)	(1.74)	(1.56)	(1.38)	(1.20)
Balance due polynomial	X	X	X	X	X
N: Bins in histogram	201	201	201	201	201
Observations	16348	5725	4553	3602	2468
R^2	0.490	0.479	0.259	0.209	0.489
			Estimates of excess sheltering		
Bunching-based upper bound	1.83***	1.68***	1.34***	1.32***	3.97***
	(0.21)	(0.34)	(0.35)	(0.40)	(0.81)
Bunching-based lower bound	1.37***	1.39***	0.99***	0.96***	2.48***
	(0.17)	(0.30)	(0.29)	(0.33)	(0.52)

Notes: Table 1, recreated with bootstrapped standard errors. Bootstrap iterations: 10,000. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.4: NLLS estimates of shift in loss domain, alternative standard errors

	(1) Full sample	(2) 1st AGI quartile	(3) 2nd AGI quartile	(4) 3rd AGI quartile	(5) 4th AGI quartile
$\tilde{s}$: $s^H - s^L$	389.37***	35.64***	70.05***	184.22***	585.93***
	(5.49)	(6.79)	(8.85)	(13.93)	(101.77)
p_1	0.80***	0.45***	0.58***	0.52***	0.64***
	(0.00)	(0.01)	(0.02)	(0.03)	(0.12)
μ	-419.08***	-392.41***	-487.87***	-621.93***	-412.11***
	(2.21)	(2.07)	(3.99)	(7.78)	(45.39)
σ_1	1058.15***	702.44***	937.59***	1585.22***	2610.20***
	(5.85)	(13.60)	(21.12)	(39.41)	(246.70)
σ_2	252.97***	246.84***	375.22***	741.72***	1218.48***
	(4.31)	(3.49)	(10.43)	(25.66)	(387.55)
N: Bins in histogram	8000	8000	8000	8000	8000
Observations	216227	57163	56799	55272	46993

Notes: Table 2, recreated with bootstrapped standard errors. Bootstrap iterations: 1000. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.5: NLLS estimates of shift in loss domain: skew-normal density

	(1) Full sample	(2) 1st AGI quartile	(3) 2nd AGI quartile	(4) 3rd AGI quartile	(5) 4th AGI quartile
$\tilde{s}$: $s^H - s^L$	405.92***	57.49***	158.70***	291.51***	917.65***
	(8.92)	(6.06)	(8.48)	(12.91)	(23.72)
ξ: location	299.15***	-85.19***	-16.48	292.43***	-1418.40***
	(11.20)	(6.34)	(16.39)	(18.69)	(106.86)
θ_ω: scale index	6.97***	6.21***	6.66***	7.28***	7.72***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.03)
α: shape	-1.63***	-1.55***	-1.19***	-1.55***	0.91***
	(0.06)	(0.07)	(0.08)	(0.07)	(0.11)
N: Bins in histogram	8000	8000	8000	8000	8000
Observations	216227	57163	56799	55272	46993

Notes: Standard errors in parentheses. Balance due expressed in 1990 dollars. Reported are nonlinear least squares estimates of the model $C_j = \text{Obs} \cdot f^{skew}(b_j + \tilde{s} \cdot I(b > 0)|\xi, \omega, \alpha) + \epsilon_j$, where $f^{skew}(b_j|\xi, \omega, \alpha)$ is the skew-normal distribution $\frac{2}{\omega}\phi\left(\frac{b_j-\xi}{\omega}\right)\Phi\left(\alpha\frac{b_j-\xi}{\omega}\right)$. In this equation, j indexes each dollar bin of balance due b from -4000 to 4000, with zero excluded. C_j indicates frequency counts. To constrain the scale parameter away from zero, it is estimated as $\omega = 10 + \exp(\theta_\omega)$. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.6: Estimates of AGI shocks at zero balance due interacted with income source

	(1)	(2)	(3)	(4)	(5)	(6)
			Dependent Variable : Δ AGI			
Balance due = 0	946	451	1703*	482	441	942
	(743)	(747)	(979)	(1016)	(1047)	(862)
Income from Schedule C-F ≠ 0	-578***	-2344***	-699***	482***	-807***	26
	(76)	(100)	(91)	(147)	(155)	(153)
Balance due = 0	8786**	10581***	13106***	9735**	13263***	11007**
× Income from Schedule C-F ≠ 0	(4092)	(4094)	(4124)	(4770)	(4745)	(4677)
Balance due > 0		-453***	1025***		389**	1398***
		(126)	(123)		(156)	(135)
Balance due > 0		1087***	221		915***	332
× Income from Schedule C-F ≠ 0		(182)	(176)		(244)	(210)
Filing-year fixed effects	X	X	X	X	X	X
Balance due polynomial		X	X		X	X
Lagged AGI polynomial			X			X
Taxpayer fixed effects				X	X	X
N	148325	148325	148325	148325	148325	148325

Notes: Standard errors, clustered by taxpayer, in parentheses. Monetary quantities expressed in 1990 dollars. Xs indicate the presence of filing-year or taxpayer fixed effects, a third-order polynomial in lagged AGI, or a third-order polynomial in balance due interacted with $I(\text{balance due} > 0)$ to allow for discontinuity at zero. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.