Tax Refund Uncertainty: Evidence and Welfare Implications

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CFPB Research Conference

May 7, 2021

Redistributing Income Through the Tax Code

▶ Tax system both raises revenue and *redistributes* income across households

▶ These tax-based transfers (EITC, CTC...) generate large, one-time payments
  ▶ ≈ 1.5 months of income for average EITC recipient

▶ Rules determining transfers and refunds are complex

FIGURE 1
Earned Income Tax Credit
2018

Credit amount

Three children
Two children
One child
No children
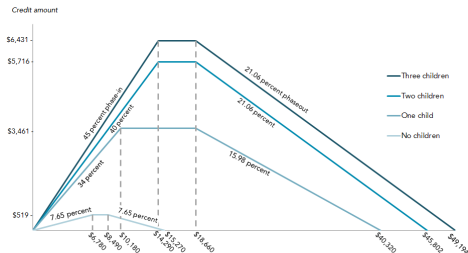
Source: Urban-Brookings Tax Policy Center (2018), Internal Revenue Procedure 2018-18, Internal Revenue Service.
Notes: Assumes all income comes from earnings. Amounts are for taxpayers filing a single or head-of-household tax return. For married couples filing a joint tax return, the credit begins to phase out at income $5,690 higher than shown.

We Study the Magnitude and Consequences of Refund Uncertainty

1. **How uncertain are low-income tax filers about annual tax refunds?**

2. **How are these expectations formed / what factors drive tax filers' uncertainty?**

3. **How costly is this uncertainty?**

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   - ▶ Survey tax filers on expectations about tax refund: point estimate & distribution
   - ▶ Link responses to current/prior tax returns + credit report data

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   - ▶ Build a simple model of belief formation/Bayesian updating to interpret patterns
   - ▶ Characterize correlates with uncertainty (demographics, features of the tax code)

3. **How costly is this uncertainty?**

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3. **How costly is this uncertainty?**
   - ▶ Link to a panel of credit reports $\implies$ infer borrowing changes
   - ▶ Calculate welfare losses, given (a range of) assumptions on risk aversion, etc.

Preview of Results

1. **Expectations are accurate; uncertainty is substantial**
   - ▶ Mean (med.) surprise is \$-63 (\$-81)
   - ▶ Mean *absolute* surprise is \$899, and 29% of tax filers face a surprise of $\geq$ \$1000
   - ▶ Uncertainty is "accurate": more uncertain filers have larger surprises

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2. **Uncertainty appears related to tax complexity, especially in the EITC**
   - ▶ Higher uncertainty for tax filers facing more complex parts of tax code: married, with dependents
   - ▶ Filers' beliefs incorporate new information about their current-year refund, consistent with Bayesian updating

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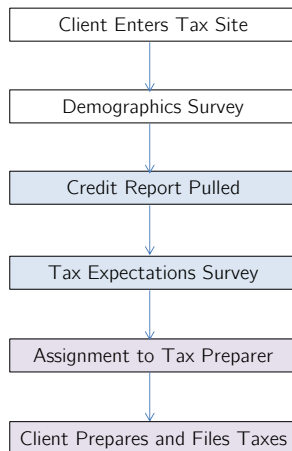3. **Tax refund uncertainty has "real" consequences**
   - ▶ Evidence for precautionary motives: uncertainty reduces smoothing of tax refund
   - ▶ Welfare cost of uncertainty is $\approx 9 - 17\%$ of EITC for average recipient $\implies$ $6-11B nationally

Related Literature

▶ Tax complexity / understanding of the tax code: Fujii & Hawley (1988)**; Chetty et al.** (2013); Chetty & Saez (2013); Bhargava & Manoli (2015); Aghion et al. (2017); Benzarti (2017); Rees-Jones & Taubinsky (2018); Zwick (2018)

▶ Effectiveness of the EITC: Meyer & Rosenbaum (2001); Eissa & Hoynes (2004, 2006); Nichols & Rothstein (2015); Hoynes & Patel (2018); **Kleven (2019)**

▶ Uncertainty and welfare: Handel & Kolstad (2015), **Luttmer & Samwick (2018)**, Finkelstein & Notowidigdo (2019)

▶ Eliciting subjective expectations: **Manski** (2004); Engelberg et al. (2009); Bruine de Bruin et al. (2010); Delavande & Rohwedder (2011); Armantier et al. (2013)

▶ Tax refunds and financial behavior: Souleles (1999); Smeeding et al. (2000); Romich & Weisner (2000); Bertrand & Morse (2009); **Jones** (2010, 2012)

▶ Prudence and precautionary motives in borrowing/consumption: Skinner (1988); **Kimball** (1990); Deaton (1991); Dynan (1993); Carroll (1997); Carroll & Samwick (1998); Jappelli & Pistaferri (2000); Gourinchas & Parker (2001); Aguiar & Hurst (2013)

Our Setting: a VITA Site in Boston

▶ Volunteer (VITA) tax preparation site in Boston

▶ Tax filers go to several stations:
  1. Intake (white): Demographic Survey
  2. Financial Guide (blue):
     ▶ Financial advising & consumer credit reports
     ▶ Consent to participate in research
     ▶ Complete expectations survey
  3. Tax Prep (purple): File Taxes

▶ We collect follow-up credit reports (1, 2, & 6 months) for consenting filers

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Our Sample

	Tax Data & Expectations Data	Tax Data, Expectations Data, & Demographics	Current and Prior Tax Data & Expectations Data	Tax Data, Expectations Data, & Credit Data
	(1)	(2)	(3)	(4)
Female	0.62	0.62	0.65	0.67
	(0.15)	(0.15)	(0.18)	(0.20)
Age	40.21	40.15	42.85	41.66
	(15.92)	(15.82)	(15.70)	(15.87)
BA Degree	0.15	0.15	0.18	0.20
	(0.36)	(0.36)	(0.38)	(0.40)
Adjusted Gross Income ($)	20,637	20,705	23,475	24,081
	(15,930)	(15,752)	(16,228)	(16,356)
Has Dependents	0.32	0.32	0.36	0.34
	(0.47)	(0.47)	(0.48)	(0.47)
Married	0.08	0.07	0.07	0.08
	(0.27)	(0.26)	(0.25)	(0.28)
Lost Job	0.08	0.07	0.07	0.06
	(0.27)	(0.26)	(0.25)	(0.24)
Observations	618	548	337	359
with Demographics	548	548	303	319

▸ Outliers   ▸ Full-Sample   ▸ Sample Selection

Our Sample

	Tax Data & Expectations Data	Tax Data, Expectations Data, & Demographics	Current and Prior Tax Data & Expectations Data	Tax Data, Expectations Data, & Credit Data
	(1)	(2)	(3)	(4)
Refund Amount ($)	1,542	1,552	1,846	1,746
	(2,207)	(2,194)	(2,385)	(2,311)
Received EITC	0.35	0.35	0.35	0.31
	(0.48)	(0.48)	(0.48)	(0.46)
EITC Credit (If >0)	1,654	1,623	1,985	1,891
	(1,661)	(1,664)	(1,796)	(1,713)
EITC share	0.50	0.49	0.53	0.46
	(0.43)	(0.38)	(0.43)	(0.40)
Estimated Savings Balance	523	523	546	634
	(576)	(576)	(583)	(606)
FICO Score	666	666	675	684
	(87)	(88)	(89)	(80)
Credit Card Balances ($)	1,686	1,780	2,005	2,630
	(4,985)	(5,228)	(5,925)	(6,026)
Observations	618	548	337	359
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▸ Outliers ▸ Full-Sample ▸ Sample Selection

Survey of Tax Refund Expectations

We elicited three versions of tax refund expectations: (▸ Survey Questions)

1. Point forecast: "If you get a tax refund this year, how much do you think it will be?"

2. Qualitative uncertainty: "How sure are you that your refund will be between
   $_ _ _ _ _ _ _ _ and $_ _ _ _ _ _ _ _?"

3. Quantitative uncertainty: "What is the "percent chance" that you think your refund could
   be..."
   ▸ Negative, $0-500, $500-1000, $1000-2500, $2500-5000, >$5000

We fit beliefs to normal distributions + use (subjective) std. to quantify uncertainty

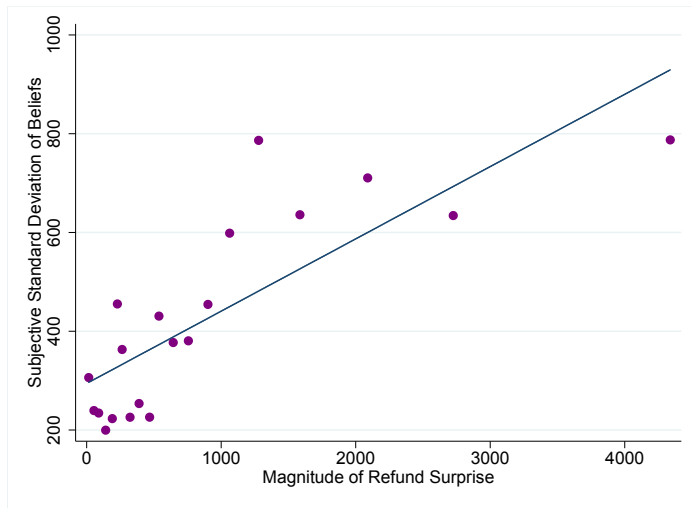(▸ Fitting Normal Distributions) (▸ Belief Formation)

Accuracy of (Mean) Expectations ▸ Density
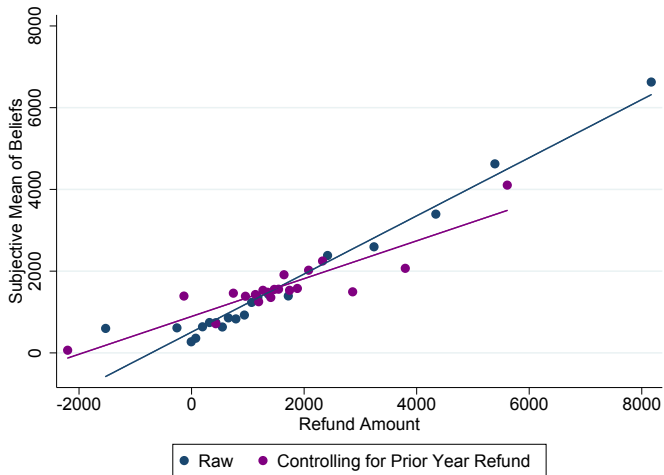
More Uncertain Filers See Larger (Absolute) Surprises

Uncertainty is Substantial in Absolute and Relative Terms

	Core Sample	Has Dependents		Marital Status		Any College		Relative to 2x Federal Poverty Line	
		Yes	No	Yes	No	Yes	No	Below	Above
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Qualitative Uncertainty									
Very Certain	34.0%	30.3%	35.7%	44.9%	33.0%	32.5%	37.3%	36.5%	29.5%
Somewhat Certain	41.7%	48.2%	38.8%	36.7%	42.2%	38.9%	42.7%	40.6%	43.8%
Not Certain At All	23.5%	21.0%	24.6%	18.4%	23.9%	27.0%	19.7%	22.1%	25.9%
Quantitative Responses									
Point Estimate	1682	3520	837	2469	1614	1656	1726	1330	2303
Features of Parametric Distribution									
Mean	1605	3365	794	2378	1539	1614	1618	1251	2229
Std. Dev.	426	769	268	648	407	448	413	353	553
Observations	618	195	423	49	569	252	279	394	224

► S.d. of transitory income shocks for avg hh is 6% of income (Guvenen et al. 2019)
► Median filer sees refund as having a s.d. that is 27% the size of refund, or 2% of pre-tax income

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Correlates of Tax Refund Uncertainty

▶ Uncertainty is higher among groups that potentially face **more tax complexity**:
  ▶ Filers with dependents
  ▶ Married filers
  ▶ Filers with large past-year changes in income

▶ The same groups generally make larger forecast errors, face larger changes in refunds, and **larger changes in marginal tax rates** (further details in paper)

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Consequences of Refund Uncertainty

Financial Behavior Before and After Tax Filing

▶ We study relationship between debt change ΔB_{it} at horizon t and expected refund μ_i and uncertainty σ_i,

$$\Delta B_{it} = \alpha_0 + \beta_1 \mu_i + \beta_2 \sigma_i + Z_i'\gamma + \eta_i$$

Z_i = demographics and "tax determinants"

▶ Possible measurement error in $\Delta B_{it} \implies$ winsorize (and probe robustness)

Impacts on Borrowing

	Baseline Model (OLS)				2SLS Estimates		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	2-Month Change in Balances						
Expected Refund Amount	-39.94	-79.23**	-44.23	-40.38	-271.7*	-199.4	-199.3
	(27.59)	(33.69)	(38.21)	(38.07)	(140.3)	(131.0)	(146.0)
Subjective Standard Deviation		227.0*	237.2*	259.3**	1339.1*	1194.6	1243.0
		(135.0)	(128.4)	(131.5)	(806.3)	(769.9)	(866.9)
					First Stage		
"Somewhat Sure" of Refund Amount					-0.154**	-0.154**	-0.140**
					(0.0598)	(0.0613)	(0.0604)
"Very Sure" of Refund Amount					-0.185***	-0.181***	-0.156***
					(0.0598)	(0.0596)	(0.0586)
Controls							
Demographics			X	X		X	X
Tax Determinants				X			X
First-stage F-stat	--	--	--	--	4.89	4.73	3.67
Observations	359	359	359	359	359	359	359
R-squared	0.009	0.018	0.079	0.096	--	--	--

▸ Binscatter ▸ Robustness

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Measuring the Welfare Costs of Uncertainty

A calibrated, simple model gives benchmark estimates of welfare cost of uncertainty

- ▶ Two periods, each with known take-home pay $c_0 = c_1$
- ▶ Uncertain tax refund y_1

Given beliefs $F_i(y)$, tax filer solves:

$$\max_b \int_y \left[u(c_{0,i} + b) + \beta u(c_{1,i} + y - Rb) \right] dF_i(y) \equiv V_i^u$$

We estimate the compensating variation for two reductions in uncertainty

- ▶ Eliminating uncertainty but not tax refund variability
- ▶ Eliminating both uncertainty and variability

Measuring the Welfare Costs of Uncertainty

Compensating variation (τ) for two reductions in uncertainty:

▶ Eliminating uncertainty but not tax refund variability

$$\int_y \left[\max_b u(c_{0,i} + b - \tau_i^{\text{nu}}) + \beta u(c_{1,i} + y - Rb - \tau_i^{\text{nu}}) \right] dF_i(y) = V_i^u$$
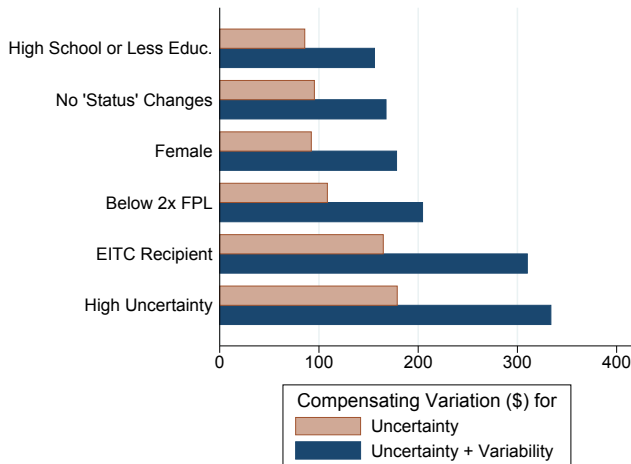
▶ Eliminating both uncertainty and variability

$$\max_b u(c_{0,i} + b - \tau_i^{\text{d}}) + \beta u(c_{1,i} + \int_y [y] dF_i(y) - Rb - \tau_i^{\text{d}}) = V_i^u$$

To implement in our data:

▶ CRRA utility with $\gamma = 1, 2, \ldots 5$

▶ c is quarterly take-home pay after tax withholding

▶ $F(y)$ is each individual's elicited belief distribution

▶ Fix $\beta = 1/R$ and $R = 1.05$ ($\approx$ credit card rates, quarterly)

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Welfare Costs of Uncertainty: $\gamma = 3$

Conclusion

1. **Tax Refund Expectations and Uncertainty**
   - ▶ Tax refund expectations are mean-unbiased but uncertain
   - ▶ Uncertainty is "accurate": larger surprises when uncertainty is higher
   - ▶ 29% of tax filers face a surprise of $\geq$ \$1000

2. **Sources of Uncertainty**
   - ▶ Higher uncertainty for tax filers facing more complex parts of tax code: married, with dependents

3. **Effects and Costs of Uncertainty**
   - ▶ More uncertain tax filers appear to borrow less of their refund before filing
   - ▶ Welfare costs maybe substantial: roughly 10% of value of EITC / \$7B nationally

Survey: Point Estimate and Qualitative Uncertainty

1) If you get a tax refund this year, how much do you think it will be? Please choose an amount:

$_____$

(Financial Guide volunteer: please write $500 above this number, and $500 below this number, in the two blank lines in the question below)

2) How sure are you that your refund will be between $_____$ and $_____$? Please circle one:

NOT SURE AT ALL   SOMEWHAT SURE   VERY SURE

Survey: Labor Supply Question

3) Suppose you want to make some extra money by working more hours next week. Do you think you could you get your manager/supervisor to schedule you for more hours?

YES

NO

I AM NOT WORKING RIGHT NOW

I AM NOT PAID HOURLY

Survey:

4) We have one final question about your tax refund. Below we show six possible amounts that your refund could be (for example, "between $1000 and $2500"). For each of the six possibilities, please say what is the "percent chance" that you think your refund could be that amount:

Could my refund be…	(Please Enter % Chance for Each)
Over $5000	%
Between $2500 and $5000	%
Between $1000 and $2500	%
Between $500 and $1000	%
Between $0 and $500	%
Negative: I will owe taxes	%

Fitting Beliefs to Normal Distributions

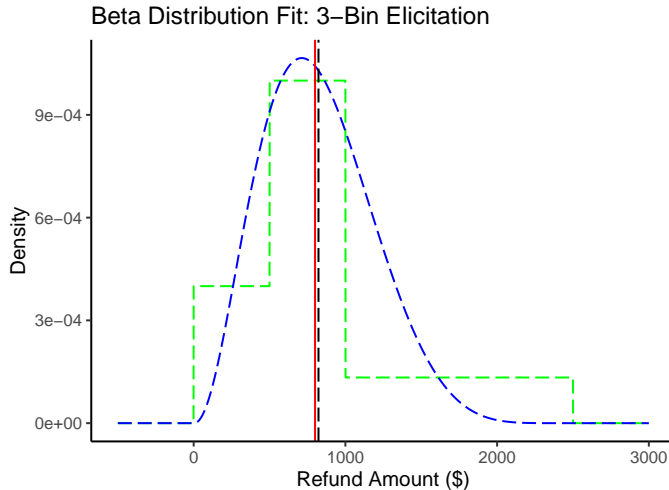We fit beliefs to normal distributions + use (subjective) std. to quantify uncertainty

$$\min_{\mu,\sigma} \sum_{x \in \mathcal{X}_i} \left[p_{x,i} - \Phi\left(\frac{x - \mu_i}{\sigma_i}\right) \right]^2 + \left(\max\{0, 1 + \Phi\left(\frac{\underline{x} - \mu_i}{\sigma_i}\right) - \Phi\left(\frac{\overline{x} - \mu_i}{\sigma_i}\right) - \alpha\} \right)^2$$

▶ p_x: cumulative probability at each interior point x

    ▶ $\overline{x}$ and $\underline{x}$ are the minimum and maximum support points

    ▶ $\alpha = .01$: precision error
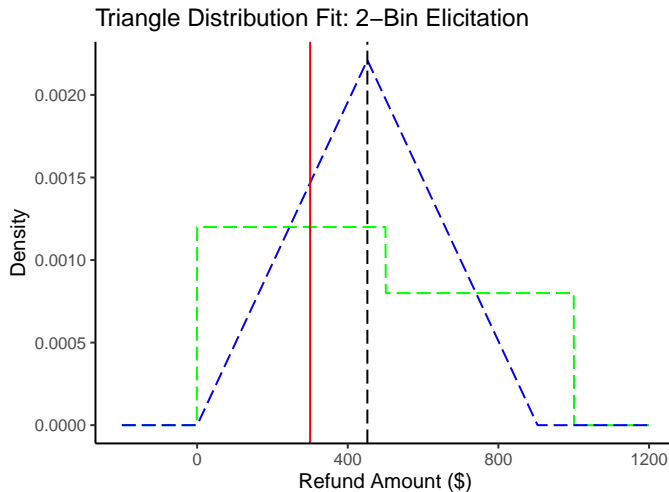
85% of respondents use two or more bins to report their expectations. ▸ Breakdown

▸ Graphical Example ▸ Beta Distribution ▸ Normal vs. Beta ▸ Beliefs by Group ▸ Back

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Fitting Beta Distributions: 3 bins
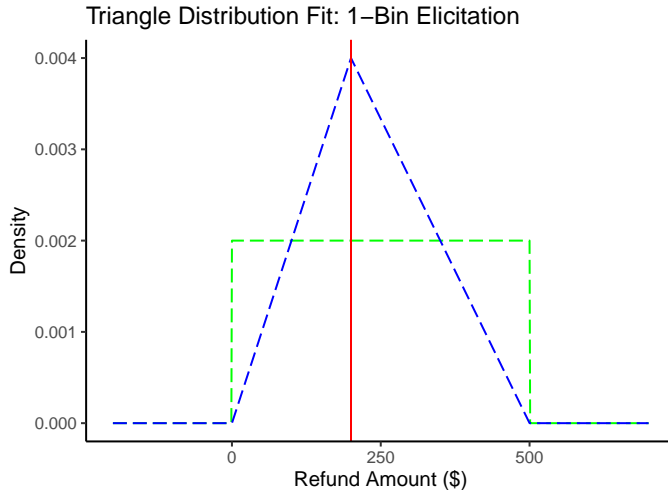
Beta Distribution Fit: 3–Bin Elicitation

Fitting Beta Distributions: 2 bins

Triangle Distribution Fit: 2–Bin Elicitation

Fitting Beta Distributions: 1 Bin

Triangle Distribution Fit: 1–Bin Elicitation

7

Fitting Normal Distributions: 3 Bins

Normal Distribution Fit: 3–Bin Elicitation

Fitting Normal Distributions: 2 Bins

Normal Distribution Fit: 2–Bin Elicitation

9
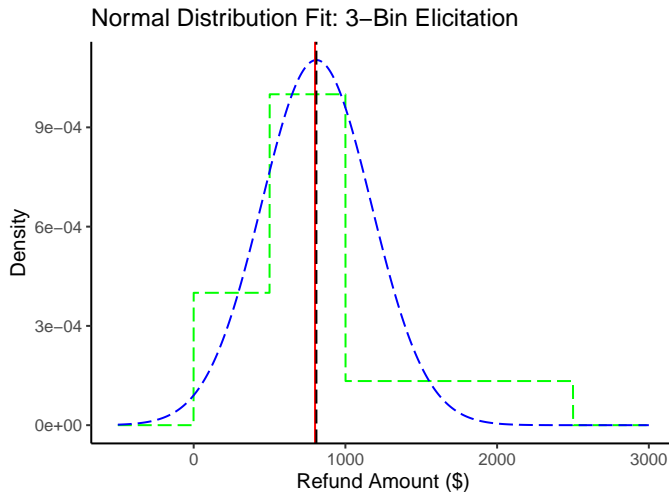
Fitting Normal Distributions: 1 Bin
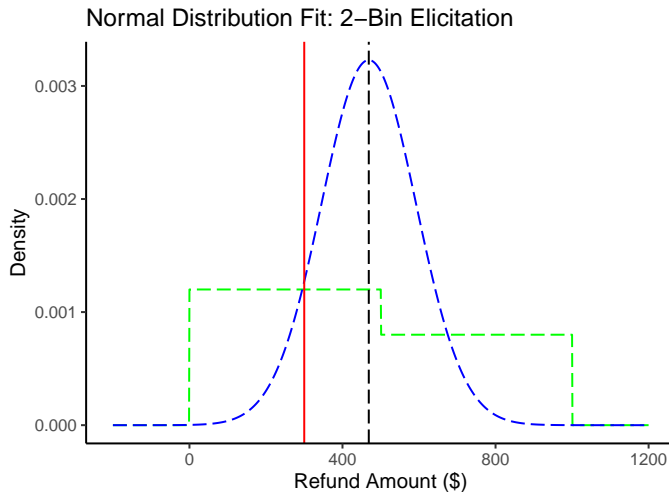
Normal Distribution Fit: 1–Bin Elicitation
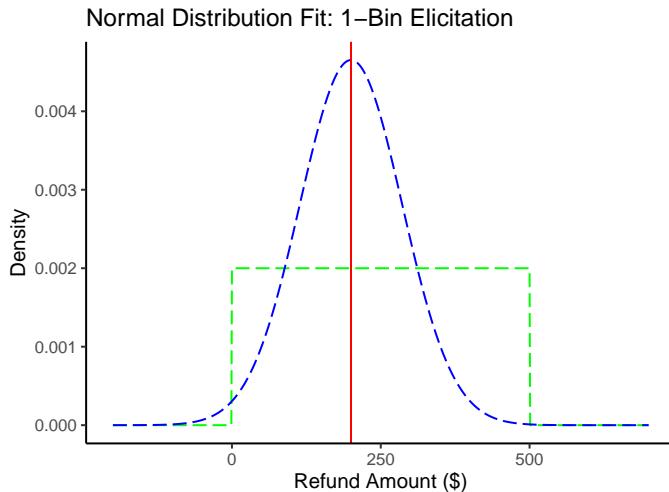
Comparing Distributional Assumptions: Normal vs. Beta
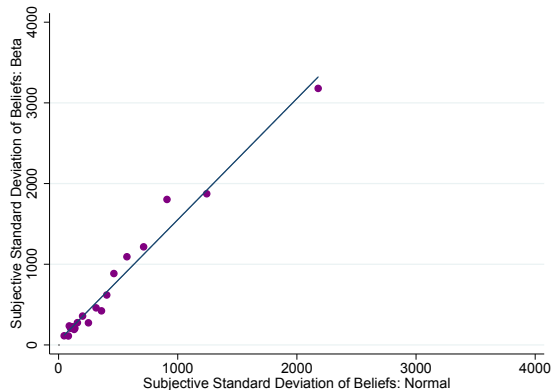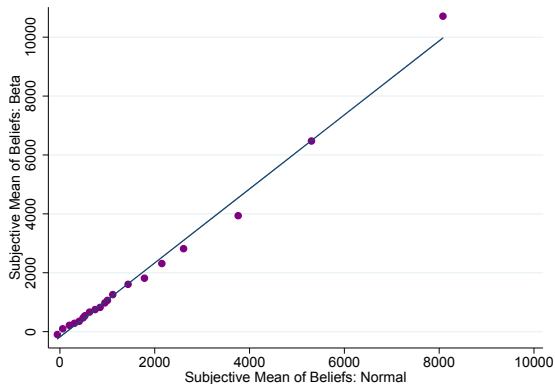
Comparing Distributional Assumptions: Normal vs. Beta

	Normal Distribution				Beta Distribution			
	Baseline	Exclude 50/50	Exclude Single Bins	All	Baseline	Exclude 50/50	Exclude Single Bins	All
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mean	1,605	1,641	1,322	1,678	1,837	1,905	1,435	1,932
	(2000)	(2061)	(1407)	(2187)	(2584)	(2698)	(1705)	(2796)
Median	1,605	1,641	1,322	1,678	1,943	2,026	1,582	2,068
	(2000)	(2061)	(1407)	(2187)	(3138)	(3299)	(2626)	(3407)
Std. Dev.	426	457	385	454	690	739	578	733
	(510)	(535)	(456)	(599)	(895)	(941)	(725)	(1005)
Observations	618	541	584	647	618	541	584	647

▶ Back

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Subjective Belief Distribution

	Mean	Standard Deviation	25th Percentile	50th Percentile	75th Percentile	Sample Size
	(1)	(2)	(3)	(4)	(5)	(6)
Qualitative Uncertainty						
Very Sure	34%	47%				618
Somewhat Sure	42%	49%				618
Not Sure	23%	42%				618
Point Forecast	1,682	2,115	400	1,000	2,000	616
Moments of Belief Distribution						
Mean	1,605.35	2,000.49	441.78	900.00	1,930.96	618
Standard Deviation	425.87	509.73	117.60	217.68	494.43	618
Coefficient of Variation	131.25	1,264.63	0.14	0.27	0.51	606
Moments as a Fraction of Income						
Mean	0.16	0.65	0.03	0.06	0.15	613
Standard Deviation	0.07	0.37	0.01	0.02	0.04	613
Change in Refund	-$92	$1,625	-$491	$12	$335	337

▸ Back

Outlier Observations
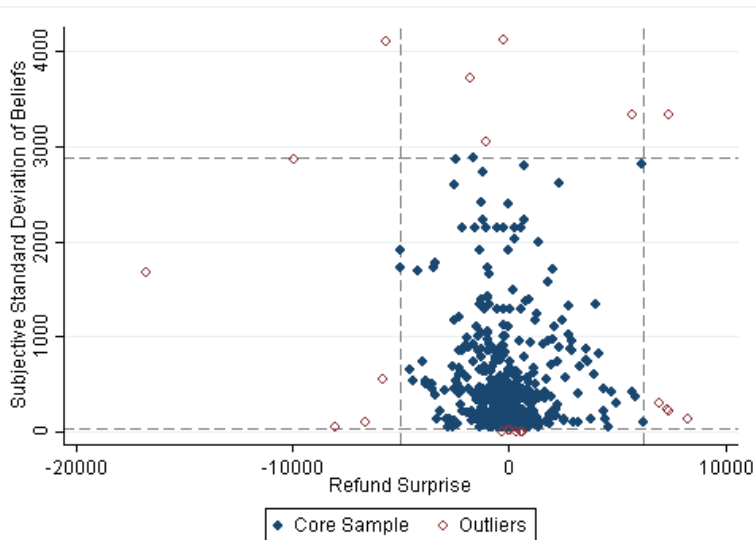
Distribution of Beliefs and Refunds

Our Sample: Including Outliers

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Female	0.62	0.62	0.62	0.65	0.68
	(0.15)	(0.15)	(0.15)	(0.17)	(0.20)
Age	40.21	40.46	40.29	42.82	41.79
	(15.92)	(15.90)	(15.78)	(15.76)	(15.96)
BA Degree	0.15	0.15	0.15	0.17	0.20
	(0.36)	(0.36)	(0.36)	(0.38)	(0.40)
Adjusted Gross Income ($)	20,637	20,998	21,041	23,844	24,311
	(15,930)	(15,941)	(15,777)	(16,126)	(16,190)
Has Dependents	0.32	0.32	0.32	0.36	0.35
	(0.47)	(0.47)	(0.47)	(0.48)	(0.48)
Married	0.08	0.08	0.07	0.07	0.08
	(0.27)	(0.28)	(0.26)	(0.25)	(0.28)
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Observations	618	692	616	375	400
with Demographics	548	616	616	339	357

▸ Outliers ▸ Full-Sample ▸ Sample Selection

Sample Selection Criteria

▶ Exclude outlier observations (▶ Outliers)

  ▶ Individuals with subjective uncertainty in the top/bottom 1% of respondents
  ▶ Individuals with expectation errors in the top/bottom 1% of respondents
  ▶ Individuals with AGI below 0

▶ Exclude individuals with point forecasts that did not fall within the support of bins used to report subjective probabilities

▶ Exclude individuals whose point forecasts did not sum to 100%

(▶ Core Sample)

Our Sample: Including-Outliers

	Core Sample	All Filers			
	Tax Data & Expectations Data	Tax Data & Expectations Data	Tax Data, Expectations Data, & Demographics	Current and Prior Tax Data & Expectations Data	Tax Data, Expectations Data, & Credit Data
	(1)	(2)	(3)	(4)	(5)
Refund Amount ($)	1,542	1,585	1,605	1,867	1,745
	(2,207)	(2,372)	(2,383)	(2,511)	(2,508)
Received EITC	0.35	0.35	0.35	0.35	0.31
	(0.48)	(0.48)	(0.48)	(0.48)	(0.46)
EITC Credit (If >0)	1,654	1,730	1,723	2,008	1,957
	(1,661)	(1,703)	(1,717)	(1,796)	(1,746)
EITC share	0.50	0.50	0.49	0.53	0.46
	(0.43)	(0.42)	(0.37)	(0.41)	(0.38)
Chose Direct Deposit	0.59	0.58	0.58	0.63	0.65
	(0.49)	(0.49)	(0.49)	(0.48)	(0.48)
Estimated Savings Balance	523	522	522	543	627
	(576)	(572)	(572)	(580)	(603)
FICO Score	666	664	663	672	682
	(87)	(86)	(86)	(87)	(80)
Credit Card Balances ($)	1,686	1,680	1,749	1,954	2,638
	(4,985)	(4,836)	(5,029)	(5,698)	(5,850)
Observations	618	692	616	375	400
with Demographics	548	616	616	339	357

▸ Outliers   ▸ Full-Sample

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Bins by Group

	Core Sample	Has Dependents		Married		Any College		Relative to 2x Federal Poverty Line	
		Yes	No	Yes	No	Yes	No	Below	Above
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Number of Bins with Positive Probability									
1 Bin	22.2%	24.1%	21.3%	22.4%	22.1%	20.6%	24.4%	20.6%	25.0%
2 Bins	38.7%	39.0%	38.5%	36.7%	38.8%	37.3%	39.4%	40.9%	34.8%
3 Bins	20.7%	16.4%	22.7%	14.3%	21.3%	19.4%	20.1%	21.6%	19.2%
4 Bins	11.0%	11.3%	10.9%	12.2%	10.9%	13.5%	9.7%	10.2%	12.5%
5 Bins	5.0%	7.2%	4.0%	8.2%	4.7%	6.3%	3.9%	4.8%	5.4%
6 Bins	2.4%	2.1%	2.6%	6.1%	2.1%	2.8%	2.5%	2.0%	3.1%
Observations	618	195	423	49	569	252	279	394	224

▸ Back

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Impacts on Borrowing
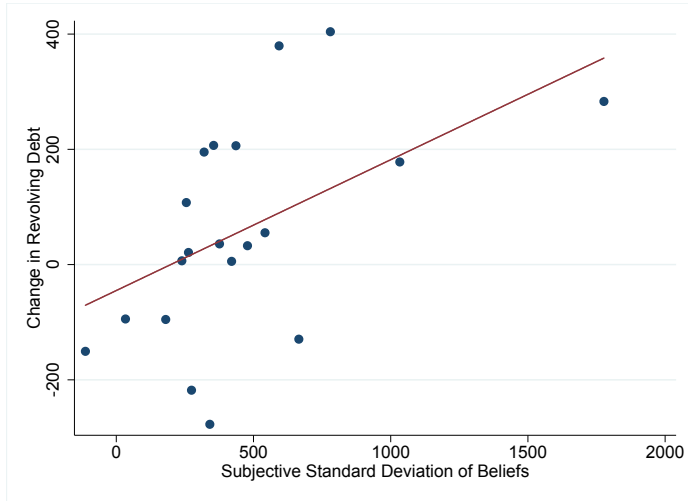
Robustness of Borrowing Results

▶ Mis-measurement of Uncertainty
  ▶ Instrument using qualitative measures
  ▶ Estimate specifications using beliefs fit to beta (rather than normal) distributions ↪

▶ ΔB_i is a proxy for borrowing: what if individuals self-insure through other channels? ↪
  ▶ Savings: filers that did not choose direct deposit, or that had no/little savings
  ▶ Labor supply: filers who said they could not change their hours when desired

▶ Omitted Variables Bias ↪
  ▶ Flexible controls for realized refund and for income

▸ Back

Robustness of Borrowing: Alternate Samples

	Baseline	Alternate Samples				Additional Specifications			
		No Direct Deposit	No Savings	Can't Change Income	No Dependents	Refund Controls	Income Controls	Refund & Income	Winsorize at 1%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Expected Refund Amount	-40.38	-6.266	-35.28	-0.487	-70.50	17.86	-41.14	5.019	-9.558
	(38.07)	(47.30)	(79.27)	(41.61)	(68.33)	(39.15)	(38.11)	(36.01)	(76.60)
Subjective Standard Deviation	259.3**	196.4	486.0**	370.7**	576.4**	283.3**	253.0*	252.4*	552.4**
	(131.5)	(143.1)	(203.5)	(144.6)	(133.4)	(132.1)	(131.7)	(133.8)	(256.5)
Controls									
Demographics	X	X	X	X	X	X	X	X	X
Tax Determinants	X	X	X	X	X	X	X	X	X
Refund						Linear		Cubic	
Income							Linear	Cubic	
Observations	359	234	91	211	237	359	359	359	359
R-squared	0.096	0.103	0.273	0.13	0.107	0.112	0.097	0.12	0.073

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Robustness of Borrowing Results: Alternate Specifications

	Baseline	Alternate Samples				Additional Specifications			
		No Direct Deposit	No Savings	Can't Change Income	No Dependents	Refund Controls	Income Controls	Refund & Income	Winsorize at 1%
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Expected Refund Amount	-40.38	-6.266	-35.28	-0.487	-70.50	17.86	-41.14	5.019	-9.558
	(38.07)	(47.30)	(79.27)	(41.61)	(68.33)	(39.15)	(38.11)	(36.01)	(76.60)
Subjective Standard Deviation	259.3**	196.4	486.0**	370.7**	576.4**	283.3**	253.0*	252.4*	552.4**
	(131.5)	(143.1)	(203.5)	(144.6)	(133.4)	(132.1)	(131.7)	(133.8)	(256.5)
Controls									
Demographics	X	X	X	X	X	X	X	X	X
Tax Determinants	X	X	X	X	X	X	X	X	X
Refund						Linear		Cubic	
Income							Linear	Cubic	
Observations	359	234	91	211	237	359	359	359	359
R-squared	0.096	0.103	0.273	0.13	0.107	0.112	0.097	0.12	0.073

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Robustness of Borrowing Results: Beta Distribution

	Baseline	Alternate Belief Distribution: Beta Distribution				LIML
		Full Sample	No Direct Deposit	No Savings	Can't Change Income	
	(1)	(2)	(3)	(4)	(5)	(6)
Expected Refund Amount	-40.38	-54.92	-10.04	-68.22	-33.69	-208.5
	(38.07)	(44.14)	(48.67)	(93.92)	(49.81)	(155.2)
Subjective Standard Deviation	259.3**	154.0	48.57	329.0*	224.6*	1300.1
	(131.5)	(120.6)	(116.0)	(193.8)	(135.7)	(924.9)
Controls						
Demographics	X	X	X	X	X	X
Tax Determinants	X	X	X	X	X	X
Observations	359	359	234	91	211	359
R-squared	0.096	0.092	0.092	0.255	0.114	---

Filers as Bayesian Updaters

▶ Priors are centered at the prior-year refund $r_{0,i}$

$$m_{0,i} \sim N(r_{0,i}, 1/h_0(X_i))$$

▶ Filers have private signals about the *change* in their refund, $\Delta r_i + \epsilon_i$, where $\epsilon_i \sim N(0, 1/h_\epsilon(X_i))$

▶ Posterior beliefs:

$$m_{1,i} = r_{0,i} + \underbrace{\frac{h_\epsilon(X_i)}{h_0(X_i) + h_\epsilon(X_i)}}_{\equiv I(X_i)}(\Delta r_i + \epsilon)$$

▶ Updating:s

$$\underbrace{m_{1,i} - r_{0,i}}_{\text{update}} = (r_{1,i} - r_{0,i}) \times \underbrace{I(X_i)}_{X_i'\beta} + \epsilon \times I(X_i)$$

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Updating by Group

	Number of Filers	Fraction with ratio of expected and realized change			Mean Ratio (%)
		< 0	[0,100]	> 100	
	(1)	(2)	(3)	(3)	(4)
All	324	23.8%	48.0%	28.2%	47.4%
Male	96	18.6%	57.7%	23.7%	43.2%
Female	178	20.7%	48.9%	30.4%	58.2%
Below Median Age	151	20.7%	52.6%	26.7%	42.4%
Above Median Age	173	26.5%	44.0%	29.5%	51.8%
Has Kids	119	24.7%	48.2%	27.1%	43.0%
No Kids	205	22.4%	47.7%	29.9%	54.1%
HS or Less	138	21.6%	50.9%	27.6%	35.2%
More than HS	142	21.3%	48.6%	30.1%	62.3%
Received EITC	118	30.3%	43.1%	26.6%	38.2%
No EITC	206	18.3%	52.1%	29.6%	55.3%

Density of Updates
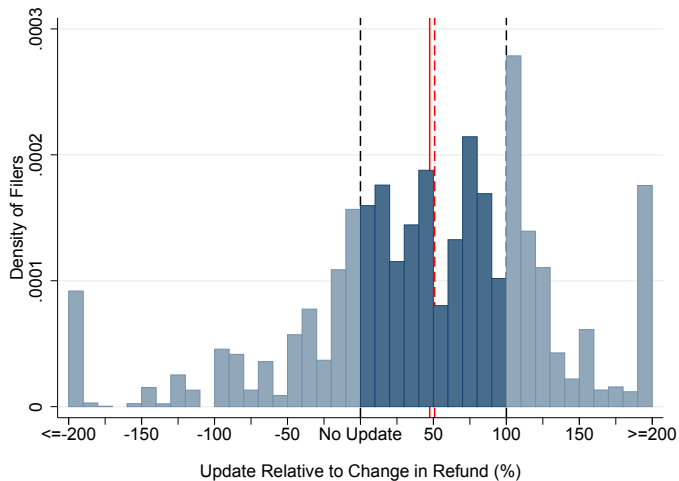
Welfare Costs of Uncertainty

	Percent of Sample (1)	Baseline Specification CRRA, Gamma=3		Alternate Specifications, CRRA Utility			
				Gamma=1		Gamma=5	
		Uncertainty (2)	Uncertainty+ Variability (3)	Uncertainty (4)	Uncertainty+ Variability (5)	Uncertainty (6)	Uncertainty+ Variability (7)
All Taxfilers	100%	92.51 [11.75] (272.56)	172.86 [24.49] (512.02)	23.63 [3.82] (60.09)	45.23 [8.72] (107.47)	127.83 [20.05] (316.78)	265.68 [40.18] (698.82)
High School or Less	45%	85.71 [12.48] (240.53)	155.95 [24.88] (419.53)	24.31 [4.02] (64.52)	45.84 [8.54] (113.37)	119.83 [21.26] (289.53)	244.20 [42.29] (609.74)
No Status Changes	47%	95.40 [10.90] (326.91)	167.61 [23.20] (571.03)	21.88 [3.54] (58.02)	41.99 [8.54] (103.31)	131.19 [18.36] (362.11)	261.56 [37.57] (781.35)
Female	52%	92.31 [15.27] (248.74)	178.20 [30.92] (488.31)	26.26 [4.95] (65.78)	49.83 [11.42] (116.41)	130.72 [26.16] (310.14)	273.23 [51.41] (680.51)
Below 2xFederal Poverty Line	64%	108.48 [12.62] (308.52)	204.40 [25.39] (595.48)	27.12 [4.04] (68.09)	50.33 [8.52] (120.24)	134.43 [21.93] (307.04)	297.78 [42.41] (761.99)
EITC Filer	35%	164.83 [33.18] (368.15)	310.01 [65.68] (710.33)	42.31 [10.43] (85.00)	79.46 [22.49] (151.83)	223.35 [57.79] (430.98)	462.92 [111.37] (934.17)
High Uncertainty Filer	50%	178.89 [46.49] (365.73)	333.73 [90.01] (687.74)	45.27 [14.25] (79.26)	85.80 [29.85] (140.61)	244.50 [72.49] (416.35)	510.19 [156.33] (925.89)

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