Household Disaggregation and Template Models

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Outline

- First version of WiNDC featured a state level dataset with a single representative agent by region.
- Provided means for spatially denominated distributional analysis, but not within consumer types.
- A key advantage of IMPLAN was its disaggregation of regional consumer demands and incomes by household income groups.
- Many ways to go about this type of disaggregation. Incomes vs. expenditures.
  - We approach this problem from the income side. Key challenges: denominate reasonable transfer income, understand income tax liabilities, savings, capital ownership vs. demands, salaries and wages.
  - Additional wrinkle: static vs. steady state calibration.
  - Income elasticities used to separate household level commodity expenditures.

What We Do

Recalibration routine:

- Two versions of a household dataset is produced. One primarily based on the Current Population Survey (CPS), and the other based primarily on IRS's Statistics of Income (SOI).
- Both versions use a bit of information from the other. Transfers and capital gains.
- Roughly comparable with 5 household types by region. Households vs. returns.

Modeling applications:

- Static vs. steady state static vs. transition dynamic models.
- Marginal cost of funds.
- Energy tax example – base dataset vs. blueNOTE.
- Impacts of COVID.

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Income Balance in the Benchmark Equilibrium

Original regional representation (subscripted by r) – limited by information in the reference input output tables:

$$cons_r + inv_r = wages_r + cap_r + other_r \quad \forall \quad r$$

- Investment based on location of state level investment demands. May not follow location of entity actually doing the investing.
- Wages and capital income based on sectors in a given state doing the demanding. Again, same issue. Furthermore, they are gross of taxes.
- Other is a closure parameter – all the stuff that can't be explained by consumption, investment, wages and capital.

Obvious issues when thinking about welfare impacts.

Toward a Better Income Balance Representation

While regional representation may limit ability to do reasonable welfare analysis, it does provide useful *control totals* that are consistent with both the National Income and Product Accounts (NIPA) and accounting identities for the rest of the economy.

This work seeks to reconcile the issues outlined in the previous slide. Move toward the following income balance representation:

$$cons_{rh} + tax_{rh} + save_{rh} = wages_{rh} + cap_{rh} + trn_{rh} \quad \forall \quad (r, h)$$

- Break out each category by region and household income type (h).
- Estimate savings for household-region pairs investing in new capital.
- Estimate wage and extant capital endowments consistent with where people actual live and work. Incorporate income taxes into WiNDC structure.
- Break out the "other" category into cash payment transfers consistent with benefits programs in US. Assume all transfers are between households and government. No intra-household transfers assumed here.

Datasets Used in Disaggregation

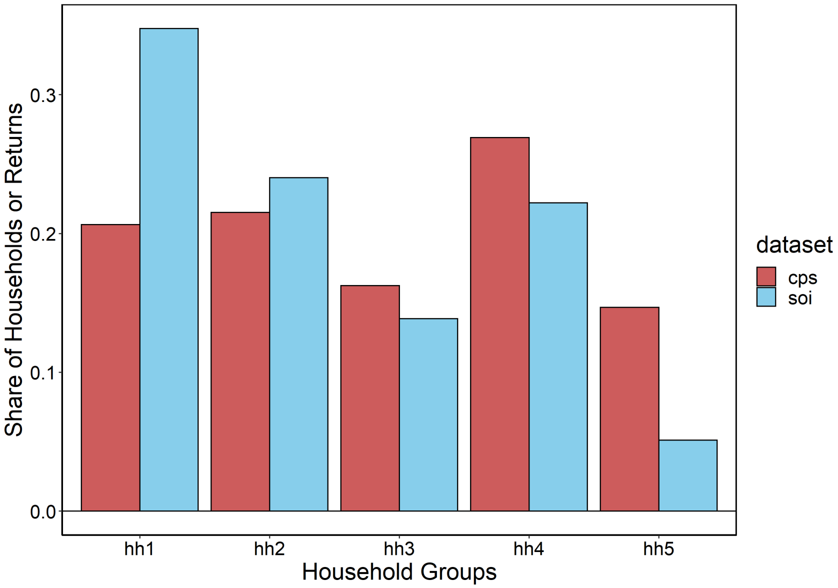
Current Population Survey (CPS)	Statistics of Income (SOI)
Survey dataset	Administrative dataset
Observation level micro-use dataset	Only have access to precompiled state-level statistics -- micro-use public file prohibitively expensive, no spatial identifier
Census defined households	Number of tax returns
Respondents report taxable and non-taxable income	Only reports taxable income (including transfers)
No income tax payments	All income tax payments for those paying taxes
Denominates all major cash trasfer payments from government programs	Transfer payments that are taxed (very limited)
Wages and salaries	Wages and salaries
Interest income (no capital gains)	Interest income (with capital gains)
Savings limited to retirement income	Savings limited to retirement income

Households vs. Number of Returns

In what follows, we aggregate households into 5 groups that *roughly* correspond with one another. Comparison between two datasets not perfect.

ID	CPS	SOI
hh1	under $25,000	under $25,000
hh2	$25,000 to $50,000	$25,000 to $50,000
hh3	$50,000 to $75,000	$50,000 to $75,000
hh4	$75,000 to $150,000	$75,000 to $200,000
hh5	over $150,000	over $200,000

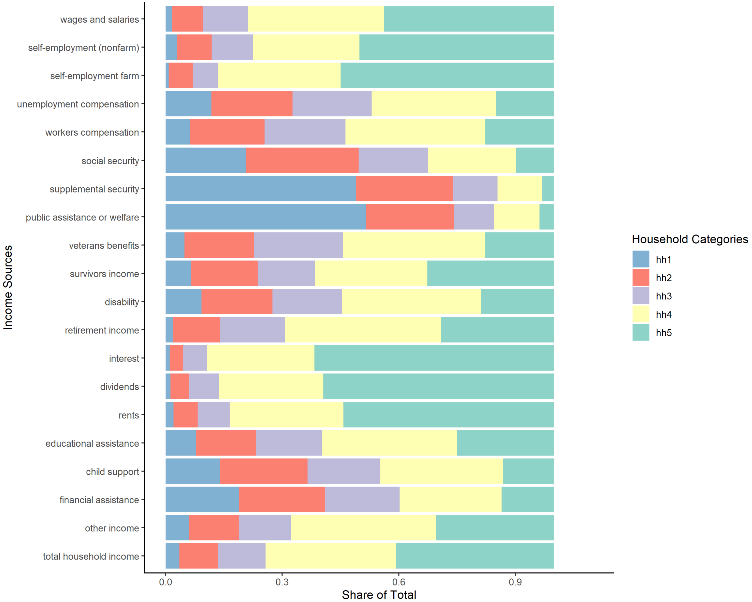
Households vs. Number of Returns



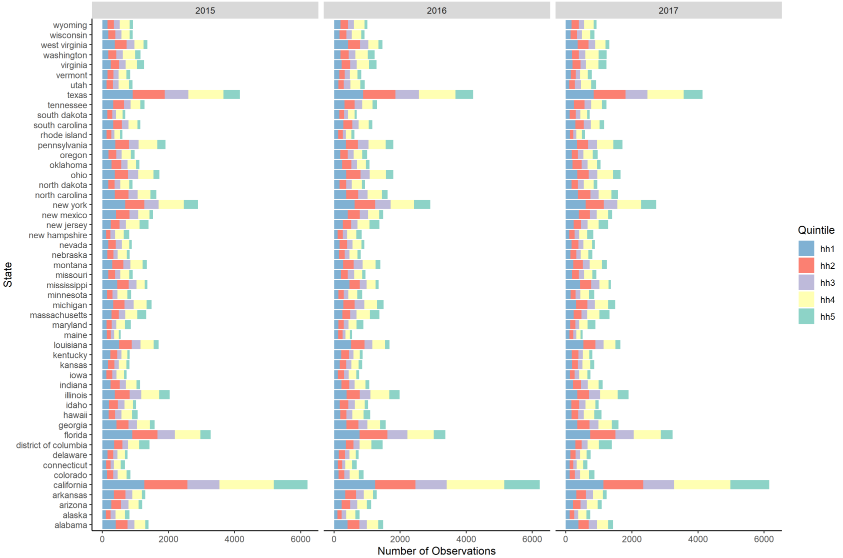
CPS Categories (2016)

Income Balance	CGE category	Data category	Total/%
Income	Labor		$7,883.57
		Wages and salaries	100%
	Capital		$952.66
		Self-employment (farm and nonfarm)	43.54%
		Interest	31.26%
		Dividends	13.58%
		Rents	10.37%
		Other income	1.24%
	Transfers		$1,113.66
		Social security	69.03%
		Educational assistance	6.09%
		Veteran's benefits	5.21%
		Supplemental security	4.44%
		Survivor's income	4.05%
		Disability	3.36%
		Financial assistance	2.43%
		Child support	2.09%
		Unemployment compensation	1.65%
		Workers compensation	1.05%
		Public assistance or welfare	0.61%
Expenditures	Savings		$545.81
		Retirement income	100%

CPS: National Level Shares (2016)



CPS: State Level Observation Count (2016)



CPS Literature on Underreporting

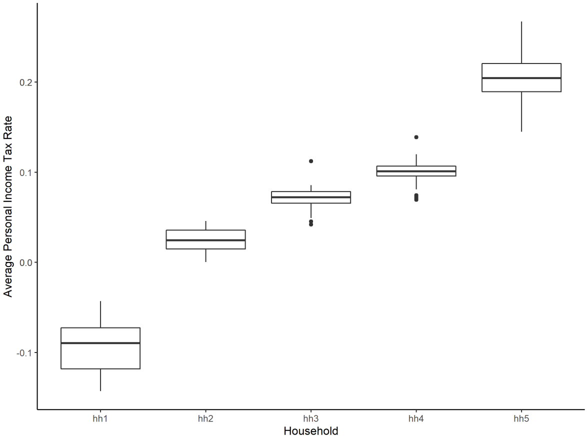
There is a healthy literature assessing CPS underreporting. Two papers that are particularly useful here:

- Meyers et al. (2009): compares CPS transfer data to administrative totals and reports share of total.
- Rothbaum (2015): compares CPS data to NIPA accounts and reports share of total for transfers not in Meyers et al. (2009) and capital income.

All transfers	0.804
Public assistance	0.487
Social security old age, survivors and disability insurance (oasdi)	0.893
Social secturity old age and survivors insurance (oasi)	0.908
Social security disability insurance (ssdi)	0.819
Supplemental security income	0.759
Unemployment insurance	0.679
Workers compensation	0.527
Veteran's payments	0.679
Interest, dividents, royalties (capital payments)	0.53

Tax Rates for CPS-based Dataset

The CPS does not include tax payments. We estimate average and marginal tax rates with CPS data and TAXSIM (v27) based on Alex Marten's code base in the SAGE model package (see: `https://www.epa.gov/environmental-economics/cge-modeling-regulatory-analysis`).



SOI Categories (2016)

Income Balance	CGE category	Data category	Total/%
Income	Labor		$7,114.21
		Wages and salaries	100%
	Capital		$3,073.52
		Rental real estate, royalties, partnerships, S corporations, trusts, etc.	21.69%
		Capital gains	19.41%
		Business income	11.22%
		Ordinary dividends	7.89%
		Qualified dividends	6.27%
		Taxable interest	2.91%
	Transfers		$310.56
		Social security benefits (taxable portion)	91.61%
		Unemployment compensation	8.39%
Expenditures	Taxes		$1,552.37
		Federal	97.86%
		State and local tax credits	2.14%
	Savings		$37.33
		Self-employed SEP, SIMPLE, and qualified plans	65.02%
		IRA deduction	34.98%

Comparison of Labor Income Taxes

While tax payments are endogenized in the routine, tax rates are held fixed.

- Overall income tax rates calculated directly from data for SOI recalibration. Labor income taxes net out taxes paid on capital income.
- CPS based taxes from TAXSIM.

Average labor income tax rates by household are computed as:

	CPS	SOI
hh1	-0.101	-0.029
hh2	0.022	0.029
hh3	0.069	0.057
hh4	0.097	0.092
hh5	0.206	0.235

Household expenditures differentiated by income group is based on expenditure elasticities from the SAGE model that were estimated using data from the Consumer Expenditure Survey. Mapped to WiNDC sectors using the PCE Bridge.

Estimated Expenditure Elasticities
(methodology from Aguiar and Bils (2015))

CEX Category	Elasticity
Alcoholic Beverages	1.1
Food and Other Beverages	0.85
Tobacco Products	0.34
Clothing and Apparel	1.13
Personal Care	1.07
Reading	0.74
Education	1.5
Medical Treatment	1.16
Entertainment	1.39
Electricity Utilities	0.31
Natural Gas Utilities	0.32
Heating Fuels	0.31
Telephone	0.65
Water Utilities	0.26
Housing	0.45
Housing Supplies and Furnishings	1.58
Vacation Home Rentals	0.6
Transportation Fuels	0.66
Vehicle Maintenance	0.78
Vehicle Financing	0.27
Vehicle Services	1.1

Structure of Recalibration Routine

The recalibration routine is run for data from 2015-2017 based on either the SOI or CPS income data. Some synergy between the two to get them roughly lined up.

- CPS based recalibration: augmented with SOI capital gains.
- SOI based recalibration: augmented with CPS transfer totals. SOI transfer data is insufficient for us because it is only taxable transfers. Most cash payment benefits aren't taxed.

Structure of Recalibration Routine

4 step process:

1. Solve for steady state equilibrium investment demands (if option is selected – static vs. steadystate).
   - Important because investment levels tie directly to the income balance constraint for households in the form of savings. Considering this upfront circumvents issues down the line.
2. Solve income routine for aggregated regions (here Census regions).
3. Solve income routine at the state level enforcing control totals at the aggregated region level.
4. Solve expenditure routine at the state level.

Successive calibration enhances reliability when solving larger model.

Step 1: Steady State Recalibration

A steady state equilibrium requires that investment and capital demands have the following relationship:

$$\sum_{g} i0_{rg} = \sum_{s} \frac{(gr + \delta)}{(ir + \delta)} kd0_{rs} \quad \forall \quad r$$

Using *gross* capital demands, reference investment is scaled by a lot (≈2x).

We impose a capital tax rate taken from SAGE (33%), which is inclusive of corporate and income taxes on capital. Using *net* capital demands, reference investment is scaled by ≈1.4x.

Note that we also recalibrate other commodity parameters to accommodate changes in $i0_{rg}$ (production, intermediate demand, regional demand).

Step 2: Income (Aggregated Regions)

Objective: minimize the deviation from either CPS or SOI data.

Key highlights:

- Assumptions on wages:
    - Labor markets clear within census regions
    - Labor demands account for overhead outside of what employees get paid directly for wages and salary. Fringe benefits are shared evenly across household types
- Note that wages, interest payments, transfers, consumption and taxes are all well controlled. Savings is calculated as a residual of the income balance condition which also determines foreign savings.
- *hh5* has much larger totals than what is in the CPS. In part due to top-coding in the survey data and smaller capital payments in CPS data.
- Matches literature well on small savings for poorer households (e.g. Zucman and Saez type work).

Step 3: Income (State Level)

Key difference to aggregated region routine:

- Labor market characterization
  - some people live and work in different states (e.g. for DC and AK)

Key innovation – adding a subscript to match the data well. e.g.

```
$demand:RA(r,h)
        d:PC(r,h)        q:c0_h(r,h)
        e:PFX            q:sum(trn,hhtrans0(r,h,trn))
        e:PL(q)          q:le0(r,q,h)
        e:PK             q:ke0(r,h)
        e:PL(q)          q:(-tx(r,h)*le0(r,q,h))
        e:PFX            q:(-sav0(r,h))
```

Given successive recalibration, implicitly assume that labor markets clear at the Census region level.

Step 4: Goods Expenditures (State Level)

Examples results:

		all	hh1	hh2	hh3	hh4	hh5
Necessities	Housing	0.16	0.305	0.232	0.194	0.196	0.103
	Utilities	0.02	0.036	0.029	0.025	0.025	0.013
Luxuries	Hospitals	0.081	0.035	0.064	0.073	0.064	0.099
	Education	0.027	0.008	0.01	0.012	0.012	0.04

Additional Thoughts

- Adding income bins would likely need some more work assessing representativeness of underlying survey data.
- Data on fringe benefit allocation.
- Jury's still out about how in-kind benefits are incorporated into input output tables.
- Comparison to IMPLAN. Will bring this work back given the finalized household build.

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Models:

1. Static model with labor-leisure choice.
2. Steady state static framework relying on Tobin's Q assumption.
3. Transition intertemporal model differentiating between households that can save and those that cannot.

Applications:

- Marginal Cost of Funds [1,2].
- Energy taxes using both a base dataset and blueNOTE dataset [1].
- COVID (requires augmenting dataset with occupations from BLS) [3].

Diagnostic Simulation #1: the MCF

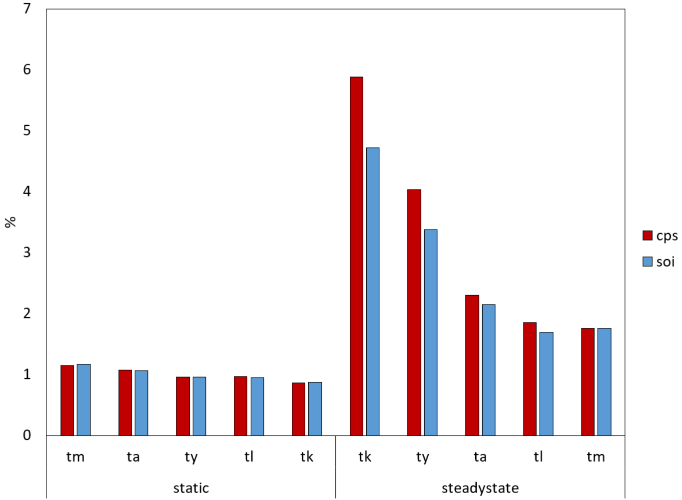
Initial calculation to discuss the welfare cost of tax instruments. Includes:

- the capital tax (TK), the labor tax (TL), indirect taxes on production (TY), sales and property taxes (TA) and the import tariff (TM).

Marginal Cost of Funds is computed as the change in equivalent variation relative to the change in increases in government income as a result of increases in the tax rate.

While not shown here, also consider alternative social welfare functions in this calculation with multiple households. Reporting changes in welfare by summing across households implicitly assumes utilitarian framework.

CPS versus SOI and **Static versus Steadystate**



Diagnostic Simulation # 2: the Double Dividend

Fullerton & Metcalf (1997): "Environmental Taxes and the Double-Dividend Hypothesis: Did You Really Expect Something for Nothing?"

The double-dividend hypothesis' suggests that increased taxes on polluting activities can provide two kinds of benefits:

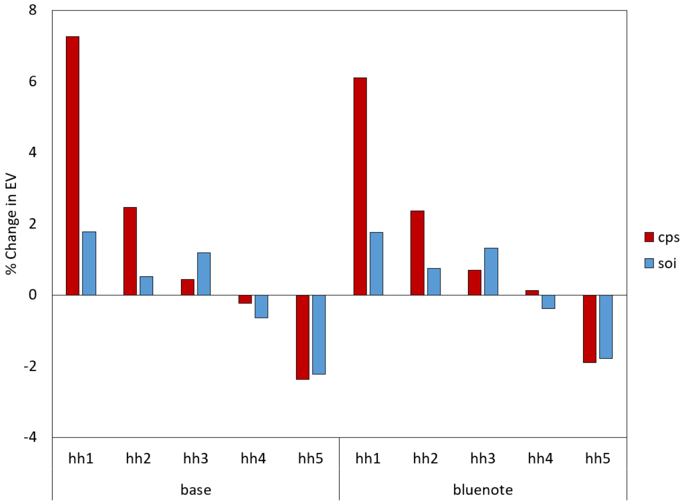
1. improvement in the environment
2. improvement in economic efficiency from the use of environmental tax revenues to reduce other taxes such as income taxes that distort labor supply and saving decisions.

Application:

- construct a minimal energy-economy model with KLEM structure and fixed factor resource supply.
- impose an ad-valorem tax on oil, natural gas and coal of 50%.
- simulate differences between base dataset and one recalibrated to SEDS using new version of blueNOTE.

Economic Cost of Energy Tax (%)

N.B.! Revenue recycled proportional to existing household transfers.



Diagnostic Simulation # 3: COVID

COVID has produced a reduction in the labor demanded by many sectors in the economy, particularly those with limited telework.

Application:

- use an intertemporal transition model to understand long run implications of a labor demand shock.
- integrate data from BLS on occupations to model jobs hit hardest by the pandemic, typically those in lower income households.
- simulate differences between a model with no occupations with one with the margin explicitly denominated.

Models are formulated by results TBD.

Thanks for listening!

Please email us with any questions that you might have:

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