Age-dependent Taxation in Australia

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Research Questions

- What is the optimal set of age-dependent income tax rates in Australia?
- How large are potential welfare gains from shifting to age-dependent taxation in Australia?
- How do existing features of Australia's economy and tax and transfer system impact these gains? (small open economy, progressive *income* taxation, age pension and other transfers, superannuation)

- Welfare gains from shifting to age-dependent taxation are large in *most* US models $\approx 1\%$ in CEV terms in Karabarbounis (2016) and Weinzerl (2011); $\approx 0\%$ in Heathcote, Storesletten and Violante (2017).
- Key mechanisms: insurance and redistribution across ages (Weinzerl 2011), efficiency / matching differences in labour supply elasticity (Karabarbounis 2016, Gervais 2012).
- Conesa, Kitao and Krueger (2009) suggest taxing capital may be a substitute for age-dependence. Progressivity has also been shown to affect the gains from age-dependence (da Costa and Santos 2018).

Methodology

- Build an OLG model that closely matches Australia's economy and tax and transfer system.
  - Model individuals (tax) and households (transfers).
  - Progressive taxation of income (labour + capital + transfers). Concessions for some types of capital income.
- Search for optimal differences in income taxation across ages.

Results

- Large welfare gains.
- Tax rates that increase sharply and monotonically with age are optimal in Australia. Ages 20-34: negative average tax rates vs. 10-30% ages 35-60 vs. above 40% for 65+.
- Largely driven by much higher asset accumulation in baseline small open economy.
- Capital accumulation and lifecycle redistribution important in closed economy.

Outline

- Model & calibration
- Baseline results
- Tax experiment
- Sensitivities

Demographics

- Overlapping generations of two member households $i \in \{m, f\}$
- Household age $j \in 20 - 24, ..., 85 - 89$
- Demographic steady state
- Stochastic household mortality: s_j probability of survival from age $j - 1$ to j. Based on ABS life tables.

Preferences

- Choices: leisure (l_j^m, l_j^f), consumption (c_j), saving (a_{j+1}).
- Maximize expected utility function:

$$E_0\Big[\sum_{j=1}^{J}\beta^{j-1}s_j u(c_j, l_j^m, l_j^f)\Big] \tag{1}$$

$$u(c_j, l_j^m, l_j^f) = (1+dp_j)log(c_j) + \gamma_j^m \frac{(l_j^m)^{1-\sigma}}{1-\sigma} + \gamma_j^f \frac{(l_j^f)^{1-\sigma}}{1-\sigma} \tag{2}$$

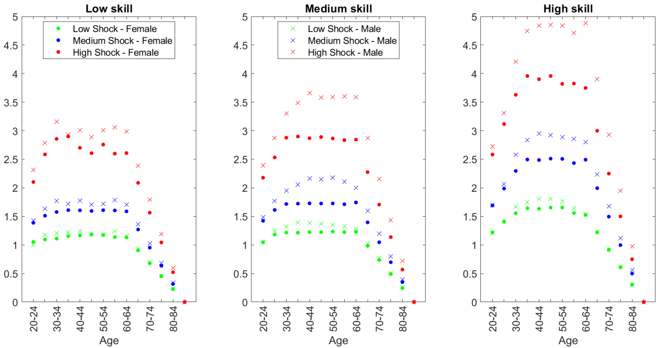
- $\sigma = 4$, dp_j = half of average dependents from HILDA, γ_j^i calibrated to match HILDA working hours.

Labour productivity

- Three skill types $n \in \{low, medium, high\}$ - fixed at birth and same for both household members.
- Three labour productivity shock states $z \in \{low, medium, high\}$. Productivity shock follows a Markov process that differs for each skill type, but not by sex. While household members face same transition probabilities, they can be in different shock states.
- Given household skill type n and individual shock type z, household member i of age j has productivity $e_j^i(n, z)$.
- Leisure is a discrete choice across six different levels that are equivalent to hours choices of 50, 40, 30, 20, 10 or 0 hours.
- Market wage w. Gives labour income $= w(1 - l_j^i)e_j^i$

Calibration

Labour Productivity ($e^i_j(n,z)$)



Notes: This graph shows labour productivity estimates from HILDA, by skill, shock, sex and age. These estimates are based on HILDA hourly wages data.

Assets, savings and superannuation

- Only asset is riskless one period bonds that pay world interest rate r. No borrowing.
- Superannuation incorporated as an endogenous saving constraint. Require households below the superannuation access age to save a strictly positive share of labour earnings ($superContribRate = 7\%$) plus the share of current assets that are superannuation ($superShare$). The variable $superShare$ differs across asset, age and labour productivity levels. It is endogenous and approximate.

Transfers

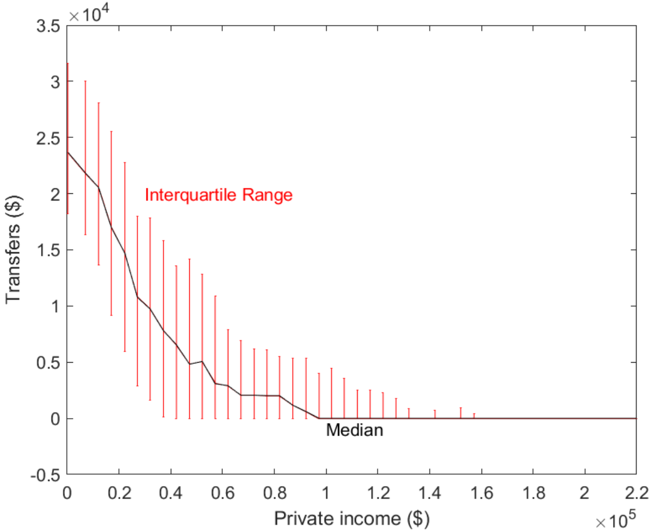
- Assessed and paid at household level. Intended to represent all transfers in Australia (unemployment benefits, disability and age pensions, family payments).
- Eligibility for transfers is a decreasing function of household income from private sources (P). Transfers zero beyond a ceiling income level κ.

$$Transfers(P,j) = \begin{cases} trans(P,j) \text{ if } P \ <= \kappa \\ 0 \text{ if } P \ > \kappa \end{cases} \tag{3}$$

$$P(x_j) = w(1 - l_j^m)e_j^m(z^m, n) + w(1 - l_j^f)e_j^f(z^f, n) + ra_j \tag{4}$$

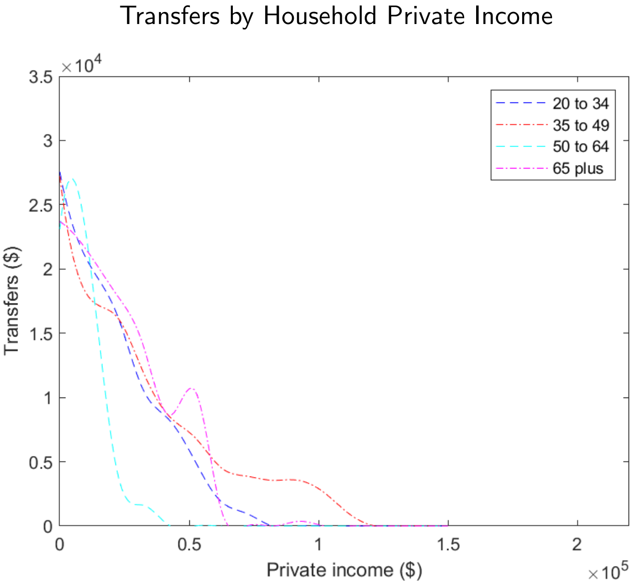
Calibration

Transfers by Household Private Income



Notes: Median and interquartile range of household transfers with each $5,000 bucket of private household income. Source: HILDA

Calibration



Notes: Estimated transfer functions for each age range. Source: Author's calculations

Taxes

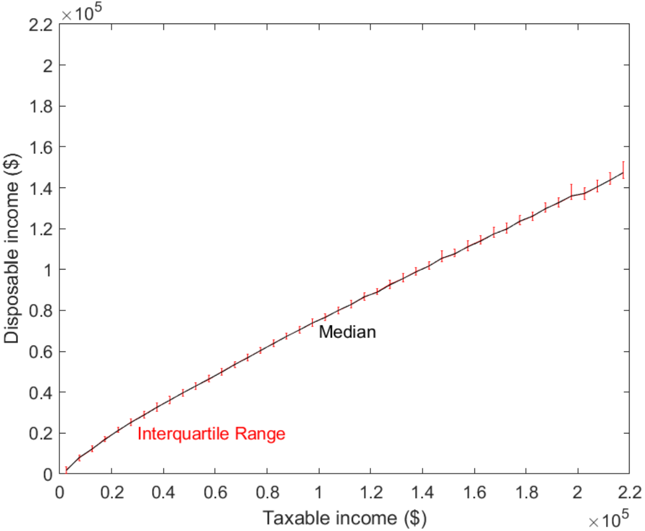
- Two-parameter income tax function (as in Karabarbounis 2016, HSV2017, Persson 1983):

$$Tax = Income - h * \tau_0^j Income^{\tau_1^j} \tag{5}$$

- τ_0 mainly controls average tax rate. Progressive if $\tau_1 < 1$
- Scaling factor h to balance government budget constraint.
- Levied on each household member individually. Asset and transfer income split equally for tax.
- Taxable income is labour income plus asset income plus transfers, less:
  - A share of asset income, $\mu_j < 1$, is untaxed. Capital gains concessions. μ_j based on ATO data. Ranges from 4% to 15%.
  - Earnings on superannuation assets. These are taxed at a flat rate, $\tau_s = 15\%$.
  - Superannuation contributions. Also taxed at τ_s.

Calibration

Taxes by Individual Total Income



Notes: The distribution of disposable income, within each $5,000 bucket of individual taxable income. Source: HILDA and author's calculations.

Calibration

$$Tax = Income - \tau_0^j Income^{\tau_1^j} \tag{6}$$

$$\implies DisposableIncome = \tau_0^j Income^{\tau_1^j} \tag{7}$$

$$ln(DisposableIncome) = ln(\tau_0^j) + \tau_1^j ln(Income) \tag{8}$$

Estimated Tax Functions

	All ages	25 to 34	35 to 49	50 to 54	65 plus
τ_0	1.824***	1.966***	1.975***	1.635***	1.789***
τ_1	0.924***	0.917***	0.916***	0.934***	0.933***
Observations	139886	30841	43373	34725	23269
Rsquared	0.993	0.995	0.994	0.994	0.986

*** indicates a p-value < 0.01

Everything else

- Production sector a single perfectly competitive firm that produces using capital and labour in a CRS production function.
- Small open economy with interest rate equal to world rate, $r = 4\%$.
- Government sector consumes G, fixed to 18% of Y. Also taxes consumption at $\tau_c = 10\%$. Balances budget each period.
- Normal conditions for steady-state competitive equilibrium.

Calibration

Summary of Model Parameters and Sources

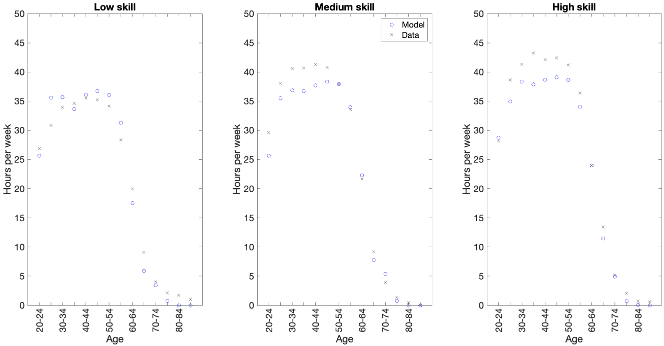
Description	Symbol	Value	Method
Household Parameters			
Life periods	J	14	Chosen (model design)
Annual population growth rate	n	1.5%	Chosen (ABS data)
Survival probabilities	s_j	Multiple	Chosen (ABS data)
Dependency ratios	dp_j	Multiple	Chosen (HILDA data)
Annual time preference parameter	β	0.979	Calibrated (targeting C/Y)
Leisure - discrete levels	$l_1, l_2, l_3, l_4, l_5, l_6$	Multiple	Chosen (model design)
Leisure weights in Utility	$\gamma_j^m; \gamma_j^f$	Multiple	Calibrated (targeting HILDA hours)
Coefficient of relative risk aversion	σ	4	Chosen (literature)
Labour productivity parameters	$e_j^i(n, z)$	Multiple	Chosen (HILDA data)
Shock transition probabilities		Multiple	Chosen (HILDA data)
Fiscal Parameters			
Private income limit for Transfers	κ	$130,000	Chosen (Data)
Consumption tax rate	τ_c	10%	Chosen (ATO data)
Government consumption	G	18% of Y	Chosen (ABS data)
Super tax rate	τ_s	15%	Chosen (ATO data)
Super contribution rate	$superContribRate$	7%	Chosen (ATO data)
Super access age	$j^{preservation}$	9 (age 60-64)	Chosen (ATO data)
Production Parameters			
Capital intensity of production	α	0.330	Calibrated (to match K/Y)
Annual depreciation rate	δ	0.068	Calibrated (to match I/Y)

Key Macroeconomic Aggregates

	Model	Data
Consumption share of output	53.7%	57.0%
Investment share of output	25.0%	26.0%
Gov Consumption share of output	18.0%	18.0%
Net exports share of output	3.4%	-1.0%
Total	*100.0%*	
Capital-to-output ratio	320.0%	315.0%
Foreign ownership of capital stock	10.2%	15.8%

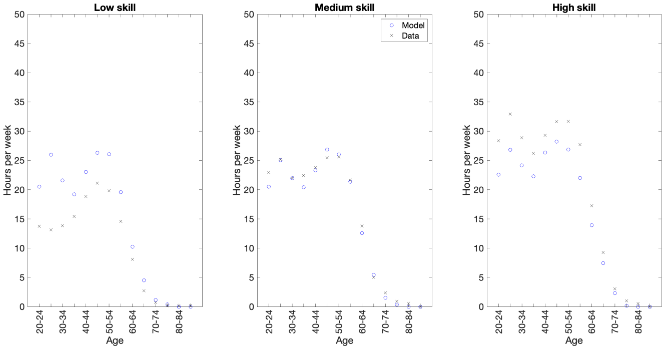
Baseline Results

Male Labour Supply by Skill Type



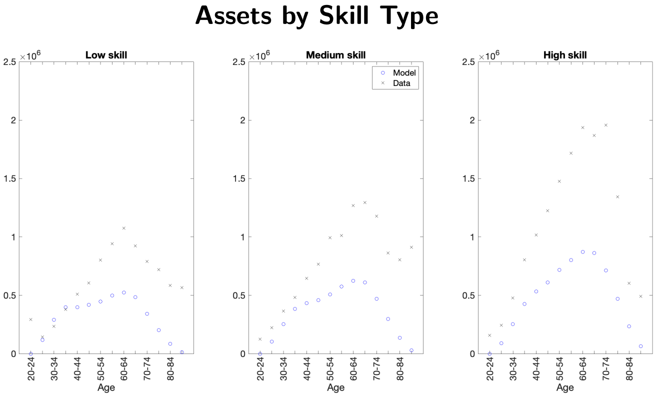
Notes: This graph compares labour supply from the baseline results to that in HILDA.

Female Labour Supply by Skill Type



Notes: This graph compares labour supply from the baseline results to that in HILDA.

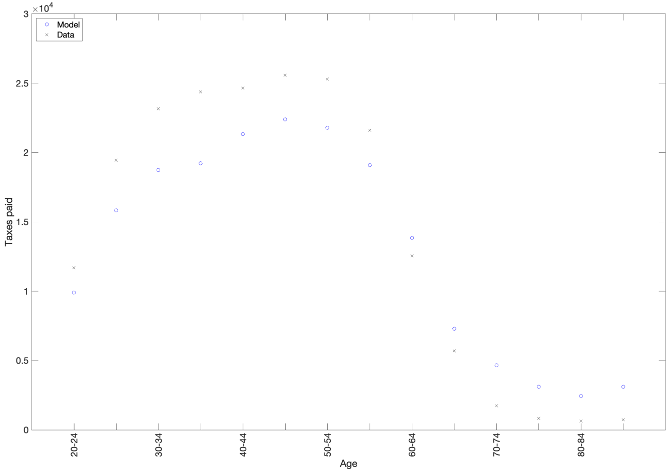
Baseline Results



Notes: This graph compares household assets from the baseline results to those in HILDA.

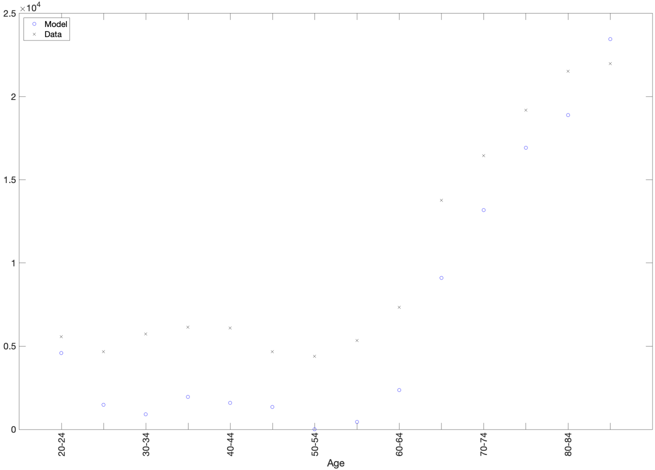
- $h = 0.95$ balances government budget constraint

Taxes by Household Age



Notes: This graph compares tax payable by household from the baseline results to those in HILDA.

Transfers by Household Age



Notes: This graph compares tax payable by household from the baseline results to those in HILDA.

- I search for the τ_0^j's that maximize the expected utility of an unborn household.
- To make computationally feasible, I search within the set of τ_0^j described by:

$$\tau_0^j = \beta_0 + \beta_1 * j + \beta_2 * j^2 \tag{9}$$

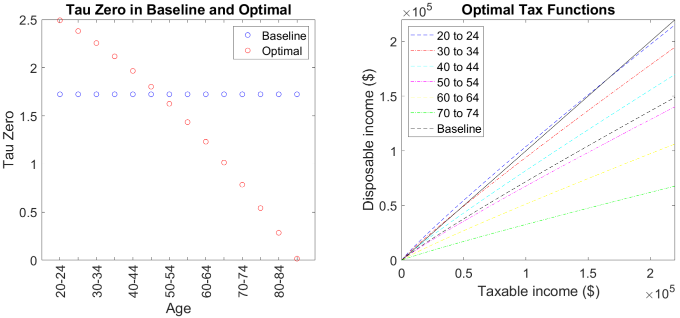
$$where \ \beta_0 = 2, abs(\beta_1) \leq \frac{1}{14}, abs(\beta_2) \leq \frac{1}{14^2} \tag{10}$$

- These β constraints limit relative differences in average tax rates between ages.

Tax Experiment

- Optimal values are $\beta_1 = -\frac{1}{14}$ and $\beta_2 = -\frac{1}{14^2}$, the lower bounds on these parameters.
- Increase in utility of 8.3% in consumption-equivalent variation terms.

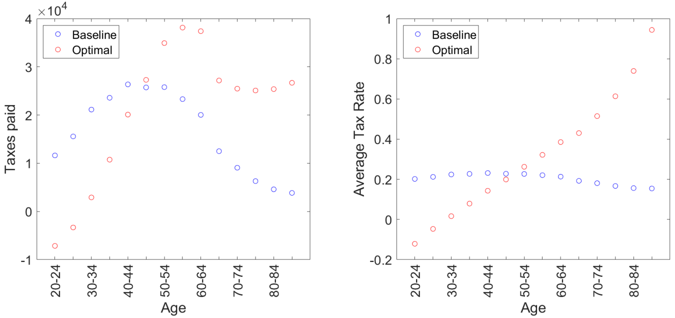
Tax Parameters: Optimal Age-dependent vs Baseline



Tax Experiment

- Younger households have negative average tax rates, so receive large transfers through the tax system for working.
- Older households face very high average tax rates.

Tax Paid: Optimal Age-dependent vs Baseline



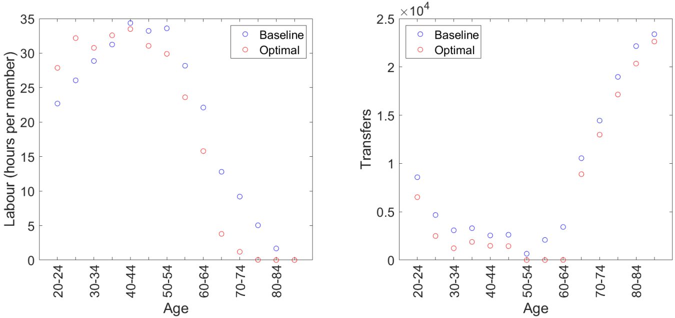
Tax Experiment

Baseline versus Optimal Results (unscaled per capita aggregates)

	Baseline	Optimal
Capital	1.98	1.93
Labour	2.06	2.00
Output	3.07	2.99
Consumption	1.62	1.75
Investment	0.85	0.83
Net Exports	0.05	-0.15
Labour earnings	2.06	2.00
Households assets	1.44	3.79
Foreign assets	0.55	-1.86
Investment earnings	0.30	0.82
Transfers	0.18	0.12
Taxes	0.58	0.49

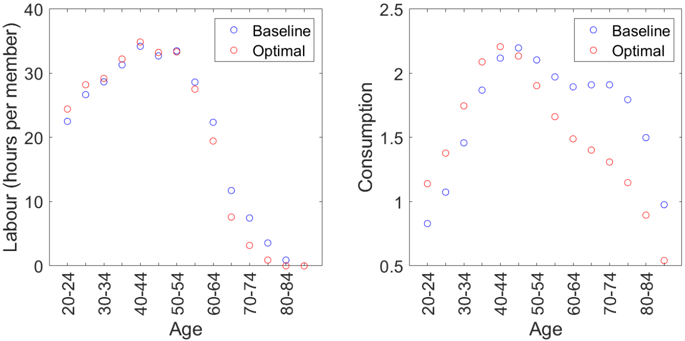
- Labour supply of younger households rises significantly in response to much lower tax rates. (Non-tax) Transfers to these households fall.
- Transfers fall at older ages due to higher asset income.

Labour and Transfers: Optimal Age-dependent vs Baseline



- $r^{closed} = 4.4\%$
- Optimal values for β and τ_0 are the same.
- Increase in utility of 1.5% in consumption-equivalent variation terms.

Labour Supply and Consumption: Optimal Age-dependent vs Baseline



Tax Experiment - Closed Economy

Baseline versus Optimal Results (unscaled per capita aggregates)

	Baseline	Optimal
Capital	1.82	2.36
Labour	2.05	2.04
r	4.4%	3.0%
w	0.97	1.06
Output	2.98	3.24
Consumption	1.66	1.63
Investment	0.78	1.03
Labour earnings	2.00	2.17
Households assets	1.82	2.36
Investment earnings	0.42	0.36
Transfers	0.16	0.19
Taxes	0.52	0.61

Tax Experiment - Closed Economy

		Consumption Equivalent Variation: Optimal vs Baseline		
	Total	Low Skill	Medium Skill	High Skill
Open Economy	8.3%	9.4%	8.0%	8.1%
Closed Economy	1.5%	1.4%	1.3%	2.0%

Next Steps

- Deconstruct these results, by re-running tax experiment and removing model elements:
  - Flatten capital tax
  - Set transfers to zero
  - Set superannuation to zero
- Consider a wider range of tax experiments: cubic of age, non-parametric (with fewer age ranges)

State space

- For households of age j, the state space is $\Omega_j = A \times Z \times Z \times N$, $A = [0, \bar{a}]$, $Z = N = \{1, 2, 3\}$.
- Convenient shorthand: let $x_j \in \Omega_j$ denote the vector of state variables of a particular household at age j

Household Problem:

$$V^j(x_j) = \max_{c_j, l_j^m, l_j^f, a_{j+1}} \{u(c_j, l_j^m, l_j^f) + \beta \frac{s_{j-1} - s_j}{s_{j-1}} E[V^{j+1}(x_{j+1}|x_j)]\}$$

for $j \in 1, ..., J$ and subject to:

$$a_{j+1} = [a_j + e_j^m(1 - l_j^m)w + e_j^f(1 - l_j^f)w + ra_j + B + Trans(x_j, j) - Tax(W^m, j) - Tax(W^f, j) - (1 + \tau_c)c_j]$$

$$a_{j+1} \geq a_j(1 + r(1 - \tau_s)) * superShare(x_j) + (e_j^m(1 - l_j^m)w + e_j^f(1 - l_j^f)w) * superContribRate$$

$$a_1 = 0$$

$$a_J = 0$$

$$l_j^i \in [l_1, l_2, l_3, l_4, l_5, l_6]$$

Exact tax functions:

$$
\begin{aligned}
Tax(W^i, j) &= W^i - h * \tau_0^j (W^i)^{\tau_1^j} \\
&+ \tau_s(r * \frac{a_j}{2} * superShare_{j,n} \\
&+ w(1 - l_j^i) e_j^i(z^i, n) * superContribRate) \\
W^i &= w(1 - l_j^i) e_j^i(z^i, n)(1 - superContribRate) \\
&+ \frac{r * a_j * (1 - \mu_j - superShare_{j,n})}{2} \\
&+ Transfers(P, j)/2
\end{aligned}
$$