Family Tax Benefits and Child Care Subsidy:
A Macroeconomic Analysis

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Public transfers to families and children

Families and children support is the second largest public transfer (2-2.5% of GDP in the past decade). Two major programs:

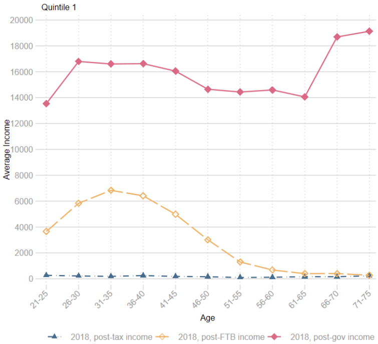
Family Tax Benefit (FTB):

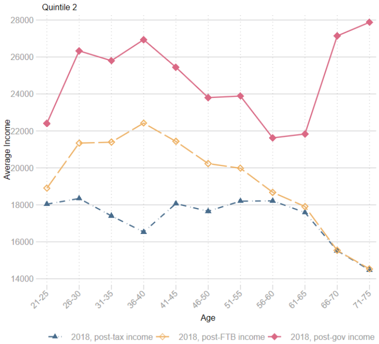
1. Highly targeted
   - Number and age of children
   - Marital status
   - Income tests: joint family income and secondary earner's income
2. **Not conditional on labor participation**.

Child Care Subsidy (CCS):

1. Highly targeted
   - Number and age of children
   - Marital status
   - Income tests: joint family income
2. **Activity test**

Family Tax Benefits for lower income households

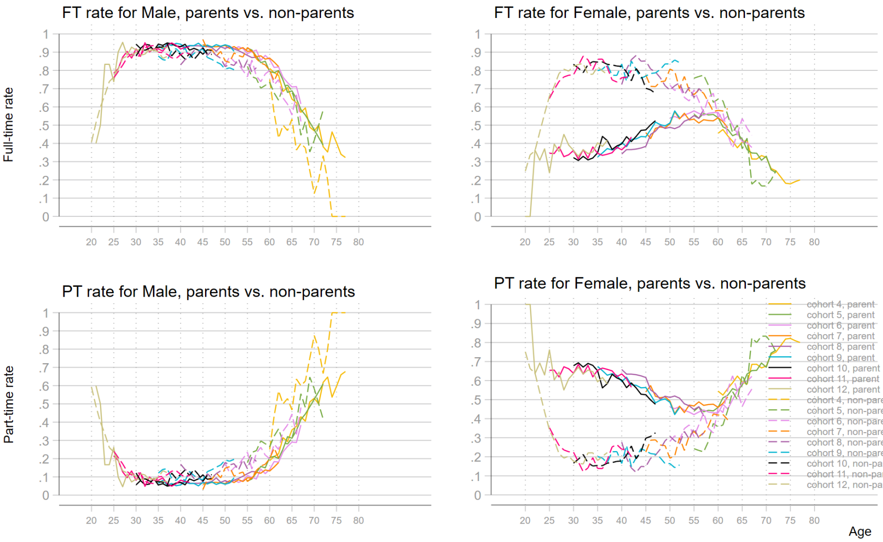




Labor dynamics

- Male: Not much difference between parents and non-parents
- Female: Parenthood is associated with a large drop in labor supply

Labor dynamics by gender and parenthood



See full time rate profiles by gender.

Our study

1. What are the macroeconomic and welfare implications of means-tested family transfers?***

2. Which is better? From what perspective (*efficiency vs. welfare*)?***

3. What are the intra- and inter-generational redistributive effects?

How?

By incorporating (i) **family structure**, (ii) **time and monetary costs of children**, and (iii) **the FTB and the CCS** into a *General Equilibrium Heterogeneous-Agent OLG framework*.

See related literature on tax and transfer using heterogeneous agent model.

Summary of findings (preliminary)

1. FTB's disincentive effect on full time work is dominant;
2. Partially offsetting effects over life cycle
   - The CCS's work incentive effect *dominates* the FTB's disincentive effect for young mothers (below 35);
3. Transfer programs interact. E.g., removing the FTB:
   - increases labor supply $\rightarrow$ higher CCS spending
   - increases savings against earnings and longevity risk $\rightarrow$ lower age-pension spending due to assets test;
   - $\rightarrow$ affects tax

Summary of findings (preliminary)

4. Macroeconomic and welfare impacts (trad-offs between efficiency and welfare) of a reform to one program depends on what is done to the other. For example,
   - From macro perspective:
     - 4.1 **remove FTB**: +16.7% female LFP, +1.1% GDP
     - 4.2 **remove FTB and CCS**: -3.6% female LFP, -3.3% GDP
     - 4.3 **remove CCS**: -15.7% female LFP, -3.48% GDP
   - From welfare perspective:
     - 4.1 **remove CCS**: -1% welfare
     - 4.2 **remove FTB**: -5.5% welfare (single mothers lose, though still have CCS that allows for lower cost of work)
     - 4.3 **remove FTB and CCS**: -51.5% welfare (single mothers lose; no support and work is too costly)

5. Overall, either cutting FTB or raising CCS creates some gains at a relatively low cost.

Model overview

A general equilibrium heterogeneous-agent OLG framework:

1. Small open economy calibrated to Australia 2012-2018;
2. Households
   - heterogeneous in age (j), types (λ), asset (a), female human capital (h^f), education (θ), transitory shocks (ϵ^m, ϵ^f);
   - deterministic and exogenous children;
   - make decision on joint consumption c, savings a^+ and female labor supply $\ell \in \{0, 1, 2\}$
3. A representative firm with Cobb-Douglas technology;
4. Government balances budget:
   - income tax, corporate income tax, consumption tax, borrowing
   - general expenditure, age pension, FTB, CCS, debt
5. Goods and factor markets clear

Demographics (1)

1. Time-invariant population growth rate (n) and survival probabilities by sex (ψ_j^m and ψ_j^f);
2. Populated by three household types:
   - Married parents, $\lambda = 0$
   - Single childless men, $\lambda = 1$
   - Single mothers, $\lambda = 2$
3. Households are born as workers at $j = 1$, retire at $j = 45$ and can live to the maximum age of $j = J = 70$;

Children

1. Only households with women have dependent children;
2. Low education (θ_L) households have children earlier;
3. Child spacing is identical for all parents;
4. Children are exogenous and fully determined by household age, j:
   - the k^{th} child is born to households aged $j = b_{k,\theta}$;
   - the k^{th} child is dependent for 18 years ($j = b_{k,\theta}$ to $j = b_{k,\theta} + 17$);
   - the number of children is

$$nc_{j,\theta} = \sum_{k=1}^{\bar{nc}} \mathbf{1}_{\{b_{k,\theta} \leq j \leq b_{k,\theta}+17\}}$$

See further details on children.

Households (working age): Costs of working for women

Women choose $\ell \in \{0,1,2\} = \{\textit{stay home, part time, full time}\}$.
If she works, she incurs:

1. A **time cost**, χ, and **time cost per child**, χ_{c,j_c}:

$$l_j^f = \begin{cases} 1 & \text{if } \ell = 0 \\ 0 < \left(1 - n^f_{j,\lambda,\ell=2}\right) < 1 & \text{if } \ell = 1 \\ 0 < \left(1 - n^f_{j,\lambda,\ell=1} - \chi - \chi_{c,j_c} \times nc_j\right) < 1 & \text{if } \ell = 2 \end{cases}$$

2. A **formal childcare cost per child** κ_j that is decreasing in the age of children:

3. A loss of a portion or all of the means-tested FTB benefits.

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Households (working age): Benefits of working for women

However, if she works, she gains:

1. Labor income

$$y^f_{j,\lambda} = wn^f_{j,\lambda}\theta h^f_{j,\lambda,\ell}\epsilon^f_j$$
$$\ln(\epsilon^f_j) = \rho^f \times \ln(\epsilon^f_{j-1}) + \upsilon^f_j; \qquad \upsilon^f_j \sim \mathcal{N}(0, \sigma^2_\epsilon)$$

2. Child care subsidy s_j per child;

3. Human capital accumulation for the next period that evolves according to a law of motion:

$$log(h^f_{j,\lambda,\ell}) = log(h^f_{j-1,\lambda,\ell}) + (\xi_{1,\lambda,\ell} + \xi_{2,\lambda,\ell} \times (j-1))\,\mathbf{1}_{\{\ell_j \neq 0\}} - \delta_\ell \mathbf{1}_{\{\ell_j = 0\}} \tag{1}$$

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Government: Family Tax Benefit part A (1)

The FTB part A is paid per dependent child.

There are 3 pairs of key parameters:

1. **Max** *and* **base** *payments per child*: $\{tr_j^{\text{A1}};\ tr_j^{\text{A2}}\}$;
2. **Income thresholds** *for max and base payments*: $\{\bar{y}_{max}^{tr};\ \bar{y}_{base}^{tr}\}$;
3. **Taper rates** *for max and base payments*: $\{\omega_{A1};\ \omega_{A2}\}$

Government: Family Tax Benefit part A (2)

Let $y_{j,\lambda} = y^m_{j,\lambda} + y^f_{j,\lambda} + ra_j$. The benefit received per child, $\boldsymbol{tr^A_j}$, is:

$$tr^A_j = \begin{cases} tr^{\mathrm{A1}}_j & \text{if } y_{j,\lambda} \leq \bar{y}^{tr}_{max} \\ \max\left\{tr^{\mathrm{A2}}_j, \quad tr^{\mathrm{A1}}_j - \omega_{A1}\left(y_{j,\lambda} - \bar{y}^{tr}_{max}\right)\right\} & \text{if } \bar{y}^{tr}_{max} < y_{j,\lambda} < \bar{y}^{tr}_{base} \\ \max\left\{0, \quad tr^{\mathrm{A2}}_j - \omega_{A2}\left(y_{j,\lambda} - \bar{y}^{tr}_{base}\right)\right\} & \text{if } y_{j,\lambda} \geq \bar{y}^{tr}_{base}, \end{cases} \tag{2}$$

Government: Family Tax Benefit part B (1)

The FTB part B is paid per household to provide additional support to single parents and single-earner parents with limited means.

There are 3 pairs of key parameters:

1. **Two max payments** *for households with children aged* $[0, 4]$ *or* $[5, 18]$: $\{tr_j^{\mathrm{B1}};\ tr_j^{\mathrm{B2}}\}$;
2. **Separate income thresholds** *for* y_{pe} *and* y_{se}: $\{\bar{y}_{pe}^{tr};\ \bar{y}_{se}^{tr}\}$;
3. *A* **taper rate** *based on* y_{se}: ω_B

Where

- $y_{pe} = \max(y_{j,\lambda}^{m},\ y_{j,\lambda}^{f})$ is the primary earner's income
- $y_{se} = \min(y_{j,\lambda}^{m},\ y_{j,\lambda}^{f})$ is the secondary earner's income

See FTB part B formula.

Government: Child Care Subsidy (1)

The Child Care Subsidy (CCS) assists households with the cost of formal care for **children aged 13 or younger**.

The rate of subsidy depends on

1. **Statutory rates**: $sr = \{0.85, 0.5, 0.2, 0\}$;
2. **Income thresholds**: $\bar{y}_i^{sr}$ *for* $i \in \{1, 2, 3, 4, 5\}$;
3. **Hour thresholds** *of recognized activities*;
4. *A* **taper rate**, ω_C^i, *on household income* y_{hh}

See CCS formula.

Key Macro Variables: Model vs. Data

Moments	Benchmark economy	Data	Source
Targeted			
Capital, K/Y	3.2	3-3.3	ABS (2012-2018)
Savings, S/Y	6.5%	5-8%	ABS (2013-2018)
Mother's labor participation, LFP	63%	65-70%	HILDA (2012-2018)*
Mother's full time rate, FT	23%	26-28% (40% $\times$ LFP)	HILDA (2012-2018)*
Consumption Tax, T^C/Y	4.26%	4.50%	APH Budget Review
Company Tax, T^K/Y	4.25%	4.25%	APH Budget Review
Age Pension, P/Y	3.31%	3.20%	ABS (2012-2018)
Gini coefficient (male aged 21)	0.35	0.35	
Non-targeted			
Consumption, C/Y	53.23%	54-58%	ABS (2012-2018)
Investment, I/Y	32.30%	24-28%	ABS (2013-2018)
Income tax, T^I/Y	12.11%	11%	APH Budget Review
Tax revenue to output	20.35%	25%	ABS(2012-2018)
Child-related transfers (FTB + CCS)	2.75%	2%	ABS (2012-2018)
Gini coefficient (working age male)	0.3766	0.45	PC (2018)

Results: Benchmark vs. Experiments

	Pre-reform	remove FTB	remove CCS	remove both
	Benchmark values	Change	Change	Change
Income (Y)	1.13	1.01%	-3.48%	-3.05%
Consumption (C)	0.60	1.43%	-3.26%	-2.31%
Savings (S)	0.07	16.03%	-1.41%	18.99%
Female LFP	63.55%	10.58 p.p.	-10.00 p.p.	-2.31 p.p.
Female FT rate	24.02%	11.18 p.p.	-4.55 p.p.	0.26 p.p.
Income tax rate	19.77	-1.72%	-0.70%	-4.22%
Tax revenue	0.24	-1.46%	-5.27%	-14.05%
FTB expense	0.018306		10.89%	
CCS expense	0.013	79.23%		
Pension	0.0382	-3.14%	-3.93%	-8.12%
HEV (newborn)	0	-5.5021%	-1.00%	-51.46%**

Table: Stationary equilibria comparison

**Turning off household types, the loss is only 2%. See also experiment 2.

LFP and human capital of mothers: Benchmark

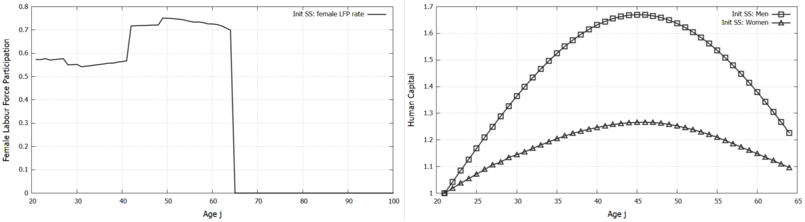


Figure: **Black line**: Benchmark

LFP and human capital of mothers: Remove FTB

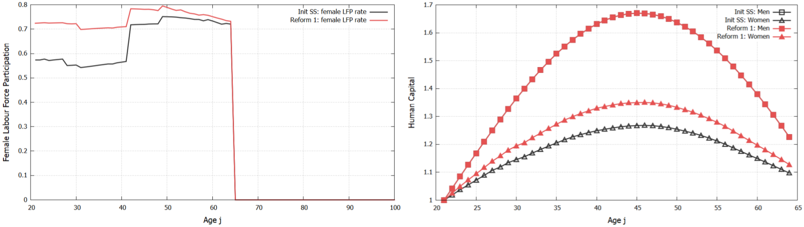


Figure: **Black line**: Benchmark, **Red line**: Reform 1 (Remove FTB, Keep CCS)

LFP and human capital of mothers: Remove CCS

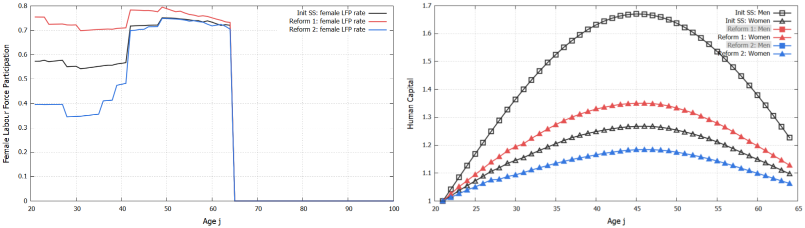


Figure: **Black line**: Benchmark, **Red line**: Reform 1 (Remove FTB, Keep CCS), **Blue line**: Reform 2 (Removing CCS, Keep FTB)

LFP and human capital of mothers: Remove FTB and CCS

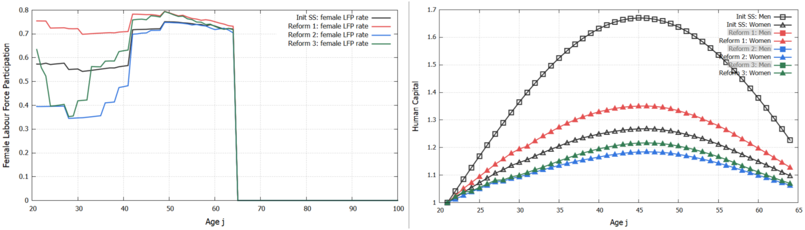
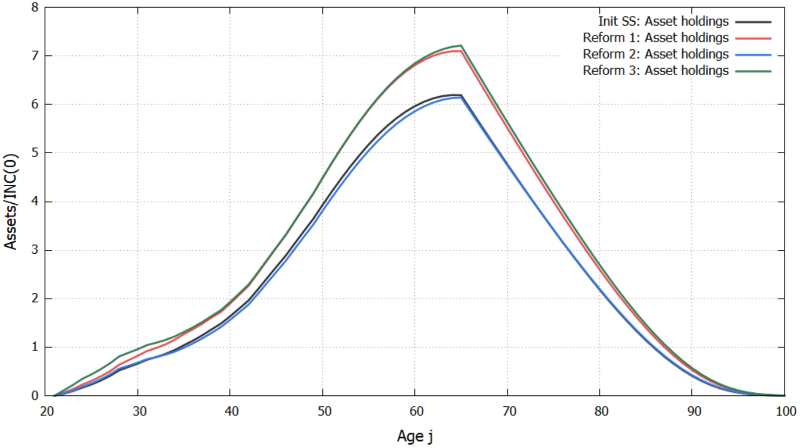


Figure: **Black line**: Benchmark, **Red line**: Reform 1 (Remove FTB, Keep CCS), **Blue line**: Reform 2 (Removing CCS, Keep FTB), **Green line**: Reform 3 (Removing FTB and CCS)

Effects on wealth over life cycle



Red line: Reform 1 (Remove FTB, Keep CCS)

Blue line: Reform 2 (Removing CCS, Keep FTB)

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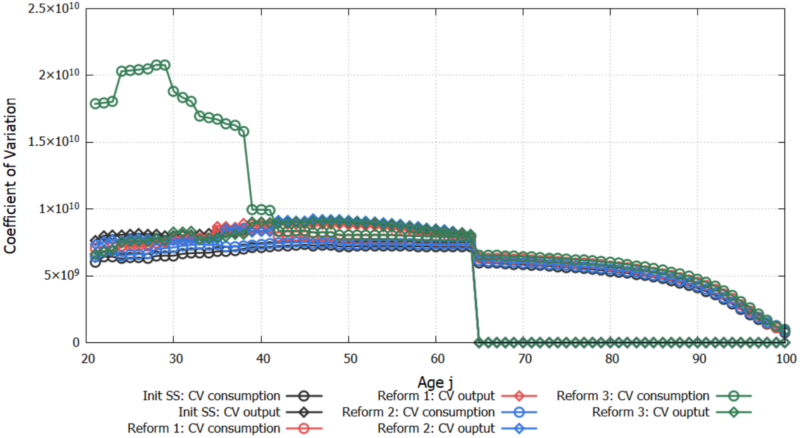
Effects on variations of output and consumption



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Conclusion

1. A unified framework incorporating the FTB and CCS into a large scale GE heterogeneous-agent OLG with family structure;

2. Lessons from a unique setting in Australia:
   - FTB part A and part B: *(i) means-tested*, *(ii) conditional on number and age of children*, but *(iii) NOT conditional on work*;
   - Child Care Subsidy: *(i) means-tested*, *(ii) conditional on work*.

3. A possible explanation on the findings by Herault and Kalb (2020) as to why tax and transfer policies contribute little to the increase in female LFP.[1]

[1] They explain the rise in female LFP rate (1990–2017 Australia) using a decomposition approach (4 explanatory factors: *wage, tax and transfer, preference, demographic composition changes*).

Future plan

Planned expansion:

1. Add new household types (e.g., married households with no children and single fathers);
2. More labor options (permanent and casual employments);
3. Endogenize intensive margin of labour supply;
4. Richer income process (See De Nardi et al. (2020));

Welfare expenditure in Australia

Financial year	Welfare ($b)	Welfare-GDP (%)	Welfare-Revenue (%)
2010–11	140.19	8.43	34.04
2011–12	149.66	8.7	34.2
2012–13	153.24	8.89	33.62
2013–14	155.68	8.88	33.47
2014–15	165.13	9.41	35.15
2015–16	167.68	9.47	34.59
2016–17	165.76	8.95	33.02
2017–18	171.62	8.99	32
2018–19	174.24	8.8	31.18
2019–20	195.71	9.86	36.05

Note: $ value is expressed in 2019–20 prices.

Source: *Australian Institute of Health and Welfare*

Welfare expenditure to GDP (%) by target groups

Financial year	Families & children	Old people	Disabled	Unemployed	Others
2009-10	2.51	3.33	1.87	0.48	0.40
2010-11	2.39	3.33	1.94	0.44	0.34
2011-12	2.33	3.43	1.98	0.44	0.52
2012-13	2.31	3.57	2.00	0.49	0.52
2013-14	2.26	3.47	2.02	0.55	0.57
2014-15	2.33	3.79	2.09	0.59	0.61
2015-16	2.32	3.86	2.08	0.60	0.62
2016-17	2.02	3.72	2.01	0.57	0.63
2017-18	1.94	3.67	2.18	0.56	0.65
2018-19	1.81	3.63	2.22	0.49	0.64
2019-20	1.92	3.85	2.53	0.93	0.62

Source: Australian Institute of Health and Welfare

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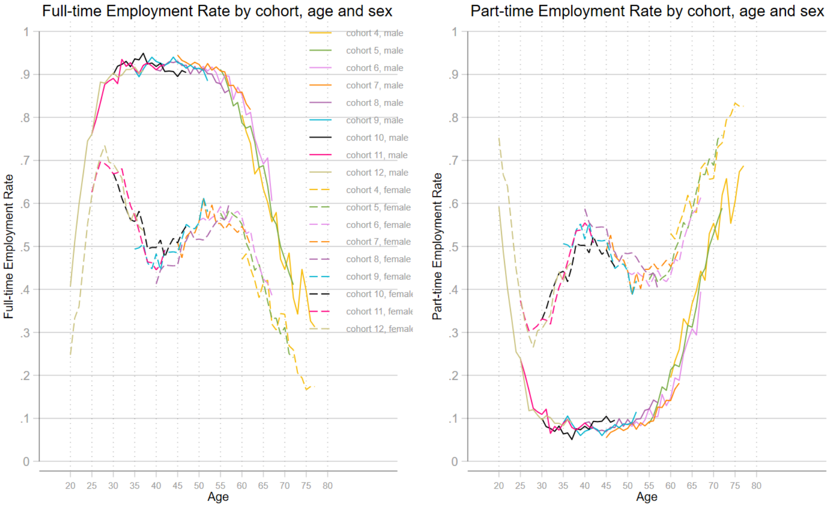
Labor dynamics by gender



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Literature

Tax-Transfer in heterogeneous agent models with family structure:

1. Joint-filing income tax
   - For proportional and separate filing income tax in the US (Guner et al., 2012a,b) and in US and 10 EU countries (Bick and Fuchs-Schundeln, 2017)
2. Spousal and survival benefits
   - For elimination (US) (Kaygusuz, 2015; Nishiyama, 2019; Borella et al., 2020)*
3. Child-related transfers
   - Expansion requires stronger evidence (US) (Guner et al., 2020)
   - Negative childcare price elasticity of labour supply (AU) (Doiron and Kalb, 2004)*
4. Old age pension
   - For (at least) partial means-tested (US) (Feldstein, 1987; Braun et al., 2017)
   - Balancing insurance and incentive effects of means-tested Age Pension (AU) (Tran and Woodland, 2014)

Demographics (2)

As in Nishiyama (2019), the household type evolves according to Markov transition probabilities:

$\pi_{h_{j+1}\mid h_j}$	$\lambda_{j+1} = 0$	$\lambda_{j+1} = 1$	$\lambda_{j+1} = 2$
$\lambda_j = 0$	$\psi_{j+1,m}\psi_{j+1,f}$	$\psi_{j+1,m}(1-\psi_{j+1,f})$	$(1-\psi_{j+1,m})\psi_{j+1,f}$
$\lambda_j = 1$	0	$\psi_{j+1,m}$	0
$\lambda_j = 2$	0	0	$\psi_{j+1,f}$

Table: Transition probabilities of household type

Households: Preferences (1)

Households born at time t maximize expected intertemporal utility:

$$\max_{c_j, l_j^f} \sum_{j=1}^{J} \beta^{j-1} \left(\prod_{s=1}^{j-1} \pi_{\lambda_{s+1}|\lambda_s}, \right) u(c_j, l_j^m, l_j^f, \lambda_j, nc_j) \qquad (3)$$

- β - discount factor;
- ψ - time-invariant survival probabilities;
- λ - household type (by marital status)
- c - joint consumption;
- l^i - leisure time of $i \in m, f$;

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Households: Preferences (2)

The periodic utility functions at age j are:

$$u(c, l^m, l^f, \lambda = 1, 0) = \frac{\left[\left(\frac{c}{ces(1,0)} \right)^{\nu} (l^m)^{1-\nu} \right]^{1-\frac{1}{\gamma}}}{1 - \frac{1}{\gamma}} \tag{4}$$

$$u(c, l^m, l^f, \lambda = 2, nc) = \frac{\left[\left(\frac{c}{ces(2,nc)} \right)^{\nu} (l^f)^{1-\nu} \right]}{1 - \frac{1}{\gamma}} \tag{5}$$

$$u(c, l^m, l^f, \lambda = 0, nc) = \frac{\left[\left(\frac{c}{ces(0,nc)} \right)^{\nu} (l^m)^{1-\nu} \right]^{1-\frac{1}{\gamma}} + \left[\left(\frac{c}{ces(0,nc)} \right)^{\nu} (l^f)^{1-\nu} \right]^{1-\frac{1}{\gamma}}}{1 - \frac{1}{\gamma}} \tag{6}$$

- Spouses are perfectly altruistic towards one another;
- $ces(\lambda, nc) = \sqrt{\mathbf{1}_{\{\lambda \neq 1\}} + \mathbf{1}_{\{\lambda \neq 2\}} + nc}$ - square root consumption equivalence scale;
- γ - intertemporal elasticity of substitution;
- ν - taste for consumption relative to leisure.

More on children...

5. Households have full information on children (e.g., arrival time, costs and benefits if work, etc);
6. No informal child care available;
7. Childcare quality and cost are identical;
8. Children leave home at 18 years old. This marks the end of the link between parents and their children;
9. No bequest motive.

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Bick (2016) finds that child care support does not increase the fertility rate in Germany. Discussed in Guner et al. (2020), evidence on child care quality is mixed. Marriage/divorce and education decisions are more likely impacted.

Households: Endowments

Labour income for $i \in \{m, f\}$ in working age $j = 1$ to $j = J_R = 45$:

$$\boldsymbol{y^i_{j,\lambda} = w n^i_{j,\lambda} e^i_{j,\lambda}}$$

- w - wage rate;
- n - exogenous labour hours ($n = 1 - l$);
- e - earning ability:

Where

$$e^m_{j,\lambda} = \bar{e}_j \left(\theta, h^m_{j,\lambda}\right) \times \epsilon^m_j$$

- *Deterministic*: θ - permanent education; h - human capital;
- *Stochastic*: ϵ - transitory shocks.

Retirees receive means-tested pension $\boldsymbol{pen(y^m_{j,\lambda} + y^f_{j,\lambda},\ a_j)}$.

Households (working age): Men

Men always works and receives labor income:

$$y_{j,\lambda}^{m} = w n_{j,\lambda}^{m} \theta h_{j,\lambda}^{m} \epsilon_{j}^{m}$$

n^m and h^m are exogenous.

The transitory shocks follow an *AR1* process:

$$\overbrace{\ln\left(\epsilon_{j}^{m}\right)}^{=\eta_{j}^{m}} = \rho^{m} \times \overbrace{\ln\left(\epsilon_{j-1}^{m}\right)}^{=\eta_{j-1}^{m}} + \upsilon_{j}^{m}; \qquad \upsilon_{j}^{m} \sim \mathcal{N}(0, \sigma_{\upsilon}^{2}) \tag{7}$$

Dynamic Optimization Problem: **Working households**

$V(z_j)$ denotes the value function for a household aged j with state $z_j = \left\{\lambda_j, a_j, h^f_{j,\lambda,\ell}, \theta, \eta^m_j, \eta^f_j\right\}$ for $j < J_R$.

$$V(z_j) = \max_{c_j,\, \ell_j,\, a_{j+1}} \{\, u(c_j, l^m_j, l^f_j, \lambda_j, nc_j) + \tag{8}$$

$$\beta \sum_{\Lambda} \int_{S^2} V(z_{j+1})\, d\Pi(\lambda_{j+1}, \eta^m_{j+1}, \eta^f_{j+1} | \lambda_j, \eta^m_j, \eta^f_j)\}$$

s.t.

$$(1+\tau^c)c_j + a_{j+1} + \mathbf{1}_{\{\lambda \neq 1,\, \ell_j > 0\}}[wn^f_{j,\lambda} \sum_{i=1}^{nc_j} (1 - s_{j,i})\kappa_{j,i}] \tag{9}$$

$$= (1+r)a_j + y_{j,\lambda} + \mathbf{1}_{\{\lambda \neq 1\}}(nc_j \times tr^A_j + tr^B_j) + beq_j - tax_j$$

$$c_j > 0 \tag{10}$$

$$a_{j+1} \geq 0 \tag{11}$$

$$l^f_j = 1 \quad \text{if } \lambda = 1 \tag{12}$$

$$0 < l^f_j < 1 - n^f_{j,\lambda,\ell} - \mathbf{1}_{\{\ell=1\}}(\chi + \chi_{c,j_c} \times nc_j) \quad \text{if } \lambda = 0 \text{ or } \lambda = 2 \tag{13}$$

Dynamic Optimization Problem: **Retirees**

Retiree's state vector is $z_j = \{a_j, \lambda_j\}$

- No labour income, no children;
- Pension is independent of labour earnings history but dependent on household type.

$$V(z_j) = \max_{c_j,\, a_{j+1}} \left\{ u(c_j, \lambda_j) + \beta \sum_{\Lambda} V(z_{j+1})\, d\Pi(\lambda_{j+1}|\lambda_j) \right\} \quad (14)$$

s.t.

$$(1+\tau^c)c_j + a_{j+1} = (1+r)a_j + pen_j - tax_j \quad (15)$$

$$c_j > 0 \quad (16)$$

$$a_{j+1} \geq 0 \text{ and } a_{J+1} = 0 \quad (17)$$

Technology

- A firm with Cobb-Douglas production and labour-augmenting technology A (with constant growth rate g):

$$Y_t = K_t^\alpha (A_t L_t)^{1-\alpha}$$

- Firm maximizes profit according to:

$$\max_{K_t, L_t} \quad (1 - \tau_t^k)(Y_t - w_t A_t L_t) - (r_t + \delta) K_t \tag{18}$$

- Firm's FOC yields:

$$r_t = (1 - \tau_t^k)\alpha \frac{Y_t}{K_t} - \delta \tag{19}$$

$$w_t = (1 - \alpha)\frac{Y_t}{A_t L_t} \tag{20}$$

Back to Model Summary

Government: Tax system

Separate tax filing for $i \in \{m, f\}$ on $\widetilde{y}_j$

If *proportional*:

$$tax^i_j = \tau^w \times \widetilde{y}_j \tag{21}$$

If *progressive*:

$$tax^i_j = \max\left\{0, \;\; \widetilde{y}_j - \zeta \widetilde{y}_j^{1-\tau}\right\} \tag{22}$$

Where

- $\widetilde{y}_j = y^i_{j,\lambda} + \mathbf{1}_{\lambda=0}\frac{ra_j}{2} + \mathbf{1}_{\lambda\neq 0} ra_j$ is the taxable income
- ζ is a scaling parameter
- τ controls progressivity of the tax scheme:
  - $\tau = 1 \implies tax^i_j = y^i_{j,\lambda}$; i.e., tax everything;
  - $\tau = 0 \implies tax^i_j = (1-\zeta) y^i_{j,\lambda}$; i.e., $(1-\zeta)$ is a flat tax rate.

Back to Model Summary

Government: Family Tax Benefit part B (2)

The benefit received per household, $\boldsymbol{tr_j^B}$, is given by:

$$tr_j^B = \tag{23}$$

$$\begin{cases} \Upsilon_1 \times tr_j^{\mathrm{B1}} + \Upsilon_2 \times tr_j^{\mathrm{B2}} & \text{if } y_{pe} \leq \bar{y}_{pe}^{tr} \text{and } y_{se} \leq \bar{y}_{se}^{tr} \\ \\ \Upsilon_1 \times \max\left\{0,\ tr_j^{\mathrm{B1}} - \omega_B\left(y_{se} - \bar{y}_{se}^{tr}\right)\right\} & \text{if } y_{pe} \leq \bar{y}_{pe}^{tr} \text{and } y_{se} > \bar{y}_{se}^{tr} \\ +\Upsilon_2 \times \max\left\{0,\ tr_j^{\mathrm{B2}} - \omega_B\left(y_{se} - \bar{y}_{se}^{tr}\right)\right\} & \end{cases}$$

Where

- $\Upsilon_1 = \mathbf{1}_{\{nc_{[0,4],j} \geq 1\}}$
- $\Upsilon_2 = \mathbf{1}_{\{nc_{[0,4],j}=0 \text{ and } (nc_{[5,15],j} \geq 1 \ \ or \ \ nc_{[16,18]_{AS},j} \geq 1)\}}$

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Government: Child Care Subsidy (2)

The rate of subsidy, $\boldsymbol{s_j}$, is:

$$s_j = \Psi(y_{j,\lambda}, n^m_{j,\lambda}, n^f_{j,\lambda}) \times \begin{cases} sr_1 & \text{if } y_{j,\lambda} \leq \bar{y}^{sr}_1 \\ max\{sr_2,\ sr_1 - \omega^1_c\} & \text{if } \bar{y}^{sr}_1 < y_{j,\lambda} < \bar{y}^{sr}_2 \\ sr_2 & \text{if } \bar{y}^{sr}_2 \leq y_{j,\lambda} < \bar{y}^{sr}_3 \\ max\{sr_3,\ sr_2 - \omega^3_c\} & \text{if } \bar{y}^{sr}_3 \leq y_{j,\lambda} < \bar{y}^{sr}_4 \\ sr_3 & \text{if } \bar{y}^{sr}_4 \leq y_{j,\lambda} < \bar{y}^{sr}_5 \\ sr_4 & \text{if } y_{j,\lambda} \geq \bar{y}^{sr}_5 \end{cases} \tag{24}$$

Where

- $\omega^i_C = \dfrac{y_{j,\lambda} - \bar{y}^{sr}_i}{\$3,000}$
- Let $n^{min}_j = min\{n^m_{j,\lambda}, n^f_{j,\lambda,\ell}\}$. The adjustment factor is

$$\Psi(y_{j,\lambda}, n^m_{j,\lambda}, n^f_{j,\lambda}) = 0 + 0.24_{\{y_{j,\lambda} \leq AU\$70{,}015,\ n^{min}_j \leq 8\}} + 0.36_{\{8 < n^{min}_j \leq 16\}} + 0.72_{\{16 < n^{min}_j \leq 48\}} + 1_{\{n^{min}_j > 48\}}$$

Goverment: Old Age Pension (1)

Pension is funded by the general government budget.

Pension is available to households aged $j \geq J_R$ and is means-tested (*income and assets tests*).

Income test:

$$\mathcal{P}^{y}\left(y_{j,\lambda}\right)=\begin{cases} p^{\max} & \text{if } y_{j,\lambda} \leq \bar{y}_1^{p} \\ \max\left\{0,\ p^{\max}-\omega_{y}\left(y_j^{p}-\bar{y}_1^{p}\right)\right\} & \text{if } y_{j,\lambda} > \bar{y}_1^{p}, \end{cases} \tag{25}$$

Asset test:

$$\mathcal{P}^{a}\left(a_{j}\right)=\begin{cases} p^{\max} & \text{if } a_j \leq \bar{a}_1 \\ \max\left\{0,\ p^{\max}-\omega_{a}\left(a_j-\bar{a}_1\right)\right\} & \text{if } a_j > \bar{a}_1, \end{cases} \tag{26}$$

Government: Old Age Pension (2)

The amount of pension benefit claimable, pen_j, is the minimum of (25) and (26). That is,

$$pen_j = \begin{cases} \min\left\{\mathcal{P}^a\left(a_j\right), \mathcal{P}^y\left(y_{j,\lambda}\right)\right\} & \text{if } j \geq J_P \text{ and } \lambda = 0 \\ \frac{2}{3}\min\left\{\mathcal{P}^a\left(a_j\right), \mathcal{P}^y\left(y_{j,\lambda}\right)\right\} & \text{if } j \geq J_P \text{ and } \lambda = 1, 2 \\ 0 & \text{otherwise} \end{cases} \tag{27}$$

Government: Budget

Government at time t collects taxes (T_t^c, T_t^K, T_t^I) and issue bond ($B_{t+1} - B_t$) to meet its debt obligation ($r_t B_t$) and its commitment to three spending programs:

- General government purchase, G_t;
- Family transfers (FTB + CCS), Tr_t;
- Old age pension, P_t.

The fiscal budget balance equation is therefore

$$(B_{t+1} - B_t) + T_t^C + T_t^K + T_t^I = G_t + Tr_t + \mathcal{P}_t + r_t B_t. \qquad (28)$$

Competitive Equilibrium: **Measure of Households**

Let $\phi_t(z)$ and $\Phi_t(z)$ denote the population growth- and mortality-unadjusted population density and cumulative distributions, respectively, and Ω_t denotes the vector of parameters at time t.

Initial distribution of newborns:

$$\begin{aligned}
\int_{\Lambda\times A\times H\times\Theta\times S^2} d\Phi_t(\lambda, a, h, \theta, \eta_m, \eta_f) &= \int_{\Lambda\times\Theta\times S^2} d\Phi_t(\lambda, 0, 0, \theta, \eta_m, \eta_f) = 1, \quad \text{and} \\
\phi_t(\lambda, 0, 0, \theta, \eta_m, \eta_f) &= \pi(\lambda)\times\pi(\theta)\times\pi(\eta_m)\times\pi(\eta_f).
\end{aligned}$$

The population density $\phi_t(z)$ evolves according to:

$$\begin{aligned}
\phi_{t+1}(z^+) = \int_{\Lambda\times A\times H\times\Theta\times S^2} & \mathbf{1}_{\{a^+=a^+(z,\Omega_t),\, h^+=h^+(z,\Omega_t)\}}\times\pi(\lambda^+|\lambda) \\
& \times\pi(\eta_m^+|\eta_m)\times\pi(\eta_f^+|\eta_f)\, d\Phi_t(z) \qquad (29)
\end{aligned}$$

Competitive Equilibrium: **Aggregation (Households)**

Given the optimal decisions $\{c(z,\Omega_t),\ \ell(z,\Omega_t),\ a(z,\Omega_t)\}_{j=1}^{J}$, the share of alive households $(\mu_{j,t})$ and the distribution of households $\phi_t(z)$ at time t, we arrive at:

$$C_t = \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} c(z,\Omega_t)\mu_{j,t}\, d\Phi_t(z) \tag{30}$$

$$A_t = \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} a(z,\Omega_t)\mu_{j,t}\, d\Phi_t(z) \tag{31}$$

$$LFP_t = \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} \mathbf{1}_{\{\ell(z,\Omega_t)\neq 0\}}\mu_{j,t}\, d\Phi_t(z). \tag{32}$$

$$LM_t = \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} h^m_{j,\lambda} e^{\theta+\eta_m}\mu_{j,t}\, d\Phi_t(z) \tag{33}$$

$$LF_t = \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} \mathbf{1}_{\{\ell(z,\Omega_t)\neq 0\}} h^f_{j,\lambda,\ell} e^{\theta+\eta_f}\mu_{j,t}\, d\Phi_t(z). \tag{34}$$

Competitive Equilibrium: **Aggregation (Government)**

Given the optimal decisions $\{c(z,\Omega_t),\ \ell(z,\Omega_t),\ a(z,\Omega_t)\}_{j=1}^{J}$, government policy parameters, the share of alive households $(\mu_{j,t})$ and the distribution of households $\phi_t(z)$ at time t, we arrive at:

$$T_t^C = \tau_t^c C_t \quad (35)$$

$$T_t^K = \tau_t^k (Y_t - w_t A_t L_t) \quad (36)$$

$$T_t^I = \sum_{j=1}^{J} \int_{\Lambda \times A \times H \times \Theta \times S^2} tax_j \mu_{j,t}\, d\Phi_t(z). \quad (37)$$

$$Tr_t = \sum_{j=1}^{J} \int_{\Lambda \times A \times H \times \Theta \times S^2} (ftba_j + ftbb_j + ccs_j)\ \mu_{j,t}\, d\Phi_t(z) \quad (38)$$

$$\mathcal{P}_t = \sum_{j=1}^{J} \int_{\Lambda \times A \times H \times \Theta \times S^2} pen_j \mu_{j,t}\, d\Phi_t(z). \quad (39)$$

Competitive Equilibrium: Definition (1)

Given the household, firm and government policy parameters, the demographic structure, the world interest rate, a steady state equilibrium is such that:

1. The collection of individual household decisions $\{c_j, \ell_j, a_{j+1}\}_{j=1}^{J}$ solve the household problem (8) and (14);
2. The firm chooses labor and capital inputs to solve the profit maximization problem (19);
3. The government budget constraint (28) is satisfied;
4. The markets for capital and labour clear:

$$K_t = A_t + B_t + B_{F,t} \tag{40}$$

$$L_t = LM_t + LF_t \tag{41}$$

Competitive Equilibrium: Definition (2)

5. Goods market clears:

$$
\begin{aligned}
Y_t &= C_t + I_t + G_t + NX_t \qquad (42)\\
NX_t &= (1+n)B_{F,t+1} - (1+r)B_{F,t}\\
B_{F,t} &= A_t - K_t - B_t
\end{aligned}
$$

Where

- $I_t = (1+n)K_{t+1} - (1-\delta)K_t$ is investment
- NX_t is the trade balance, and
- $B_{F,t}$ is the foreign capital required to clear the capital market.

Competitive Equilibrium: Definition (3)

6. The total lump-sum bequest transfer, BQ_t, is the total assets left by all deceased households at time t:

$$BQ_t = \sum_{j=1}^{J} \int_{\Lambda \times A \times H \times \Theta \times S^2} (1 - \psi_{j,\lambda})(1 + r_t) a(z, \Omega_t)\, d\Phi_t(z). \tag{43}$$

Bequest to each surviving household aged j at time t is

$$beq_{j,t} = \left[\frac{b_{j,t}}{\sum_{j=1}^{J} b_{j,t}\, m_{j,t}} \right] BQ_t \tag{44}$$

Assuming bequest is uniform among alive working-age agents, then $b_{j,t} = \frac{1}{JR-1}$ if $j < JR$ and $b_{j,t} = 0$ otherwise. Thus,

$$beq_{j,t} = \frac{BQ_t}{\sum_{j=1}^{JR-1} m_{j,t}} \tag{45}$$

Summary: Externally Calibrated Parameters (1)

Parameter	Value	Target (2012-2018)
Demographics		
Lifespan	$J = 80$	Age 21-100
Retirement	$J_R = 45$	Age 65
Population growth	$n = 1.6\%$	Average (ABS)
Survival probabilities	ψ_m, ψ_f	Average (Aus. Life Tables, ABS)
Measure of newborns by type	$\{\pi(\lambda_0), \pi(\lambda_1), \pi(\lambda_2)\} = \{0.70, 0.14, 0.16\}$	HILDA 2010-2018
Technology		
Labour augmenting tech. growth	$g = 1.3\%$	Average per capita growth rate (World Bank)
Output share of capital	$\alpha = 0.4$	Output share of capital for Australia
Real interest rate	$r = 4\%$	Average (World Bank)
Households		
Relative risk aversion	$\sigma = \frac{1}{\gamma} = 3$	standard values 2.5-3.5
Work hours	$n_{m,\lambda}$, $n_{f,\lambda}$	Age-profiles of avg. labour hours (HILDA)
Male human capital profile	h^m_λ	Age-profile of hourly wages for married men

Summary: Externally Calibrated Parameters (2)

Parameter	Value	Target
Permanent shocks		
Value	$\{\theta_L, \theta_H\} = \{0.745, 1.342\}$	College-HS wage premium of 1.8 (HILDA, 2012-2018)
Measure of $\{\theta_L, \theta_H\}$ type households	$\{\pi(\theta_L), \pi(\theta_H)\} = \{0.7, 0.3\}$	College to high school ratio (2018, ABS)
Fiscal Policy		
Consumption tax	$\tau_c = 8\%$	$\tau_c \frac{C_0}{Y_0} = 4.5\%$; $\frac{C_0}{Y_0} = 56.3\%$
Company profit tax	$\tau^k = 10.625\%$	$\tau^k \left(\frac{Y - WL}{Y}\right) = 4.25\%$; $\frac{WL}{Y} = \alpha$
Gov't debt-to-GDP	$\frac{B}{Y} = 20\%$	Average (CEIC data, 2012-2018)
Gov't general purchase	$\frac{G}{Y} = 14\%$	Net of FTB, CCS and Age Pension (WDI and AIHW)
FTB, CCS and pension parameters		HILDA Tax-Benefit model

Summary: Internally Calibrated Parameters (1)

Parameter	Value	Target
Households		
Discount factor	$\beta = 0.99$	Saving ratio $5\% - 8\%$ (ABS, 2013-2018)
Taste for consumption	$\nu = 0.365$	LFP rate for mothers = 65-70%
Time cost of non-mother's FT work	$\chi = 0.14$	Mother's full time rate = 24%
Extra time cost of mother's full time work	$\{\chi_{c,j_c=[0,6]}, \chi_{c,j_c=[7,12]}\} = \{0.025, 0.005\}$	Age-profile of full time share
Female human capital accumulation	$(\xi_{1,\lambda,\ell};\ \xi_{2,\lambda,\ell})$	Age-profile of hourly wages of male counterpart (if $\ell > 0$ every period)
Female human capital depreciation	$\delta_h = 0.074$	Peak married male-female wage gap 30% (HILDA)
Transitory shocks, ϵ		
Persistence	$\rho = 0.98$	Literature
Variance of shocks	$\sigma^2_\epsilon = 0.0145$	$GINI_{j=1,m} = 0.35$
Fiscal policy		
Progressive income tax	$\lambda = 0.7237$, $\tau = 0.2$	Tran and Zakariyya (2021)
Maximum pension	$pen^{max} = 30\% \times Y_m$	Pension/GDP = 3.2% (ABS, 2012-2018)

Calibration: Demographics (1)

1. Since child-related transfers are concentrated during child-bearing and raising age, we set one model period to correspond to 1 year of life to better capture behavioural responses;

2. Time-invariant n, ψ_m and ψ_m induce an unchanging population structure in every period t (see share of survivors).

Calibration: Demographics (2)

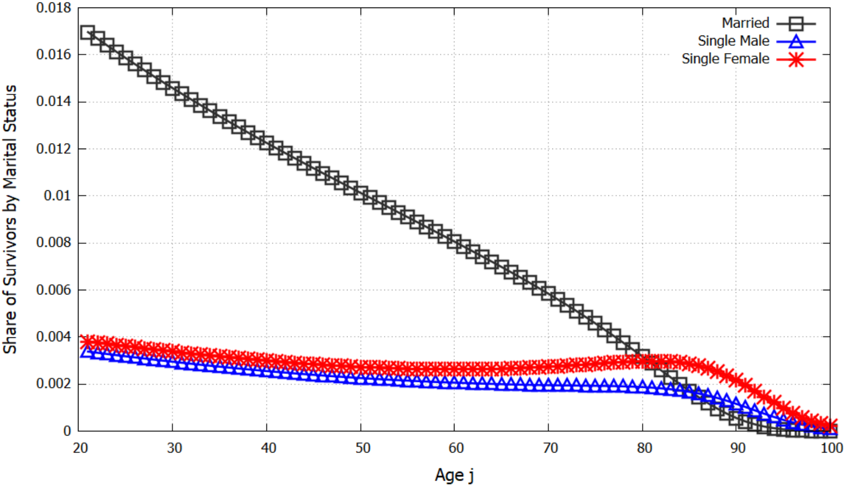

Figure: Share of survivors over life cycle

Calibration: Endowment (Deterministic) (1)

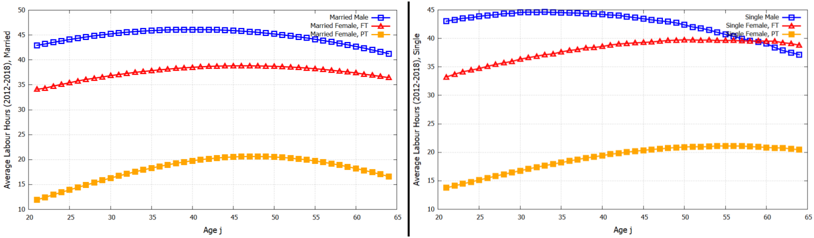

Figure: Age profiles of average labor hours

Calibration: Endowment (Deterministic) (2)

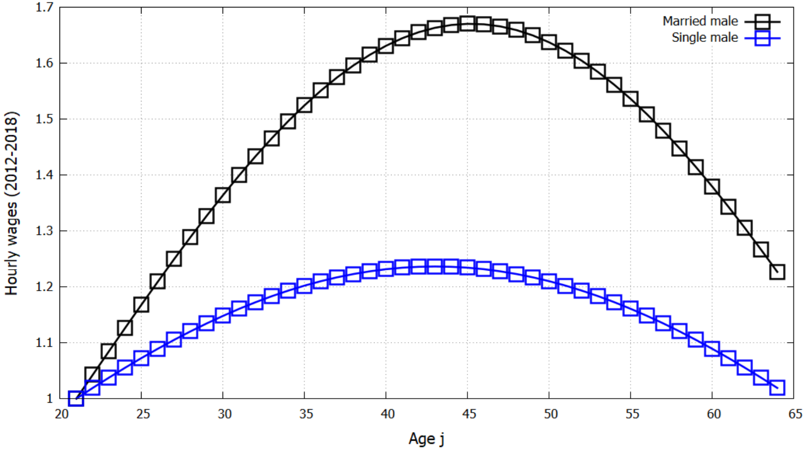

Figure: Age profiles of male hourly wages

Calibration: Endowment (Deterministic, Female)

We calibrate the female human capital accumulation rate that their human capital profiles match those of their male counterparts:

- if the wife works without time off over life cycle, and
- assuming ex-ante assortative matching of couples in terms of skills.

Our estimates are:

- Married mothers working full time: $(\xi_{1,\lambda=0,\ell=1}, \xi_{2,\lambda=0,\ell=1}) = (0.0450, -0.00175)$
- Married mothers working part time: $(\xi_{1,\lambda=0,\ell=2}, \xi_{2,\lambda=0,\ell=2}) = (0.0350, -0.00135)$
- Single mothers working full time: $(\xi_{1,\lambda=2,\ell=1}, \xi_{2,\lambda=2,\ell=1}) = (0.0206, -0.00088)$
- Single mothers working part time: $(\xi_{1,\lambda=2,\ell=2}, \xi_{2,\lambda=2,\ell=2}) = (0.0179, -0.00060)$

Calibration: Endowment (Deterministic, Children)

Children:

1. Assign *first and second child births* to
   - type θ_H households aged $\{28, 31\}$;
   - type θ_L households aged $\{21, 24\}$ (See LSAC and AIHW reports)
2. Child care service fee is \$12.5/*hour* or 48% of age 21 married male hourly wage.
3. Based on approximates from child care service and school fees, parents pay
   - 100% of the fee for child aged 0-2;
   - 80% for child aged 3-5;
   - 60% for child aged 6-11;
   - 40% for child aged 12-17.

Calibration: Endowment (Stochastic income process)

We calibrate the AR1 stochastic process, η^i, for $i \in \{m, f\}$ as follows:

- Discretized into 5 grid points:

$$\eta^i = \{0.29813,\ 0.54601,\ 1,\ 1.83146,\ 3.35424\}$$

- Transition probabilities obtained via Rouwenhorst method:

$$\begin{bmatrix} 0.9606 & 0.0388 & 0.0006 & 0 & 0 \\ 0.0097 & 0.9609 & 0.0291 & 0.0003 & 0 \\ 0.0001 & 0.0194 & 0.9610 & 0.0194 & 0.0001 \\ 0 & 0.0003 & 0.0291 & 0.9609 & 0.0097 \\ 0 & 0 & 0.0006 & 0.0388 & 0.9606 \end{bmatrix}$$

Calibration: Endowment (Stochastic income process)

- Persistence: $\rho = 0.98$;
- Variance of the innovation to shocks: $\sigma_\epsilon^2 = 0.0145$ to achieve a Gini coefficient of age 21 male wage distribution of 0.35;
- The set-up results in GINI $= 0.3766$ for wage distribution of work-age male population (not targeted).

Lorenz Curve (male wages at aged 21 and 22)

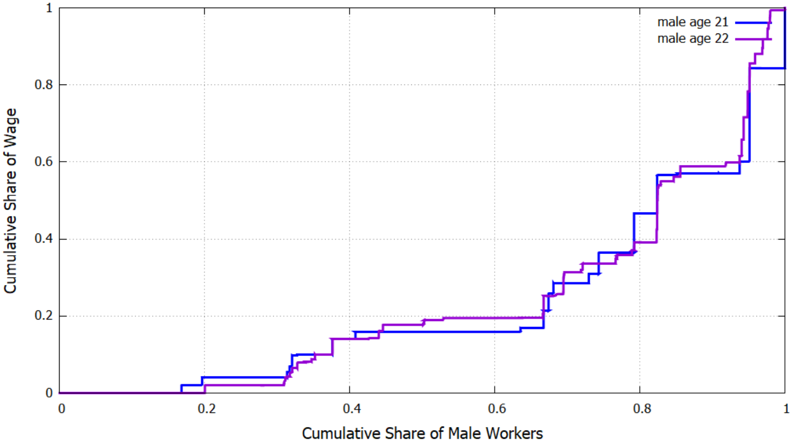

Figure: Lorenz curves of the distributions of married male wages at age 21 and 22

Lorenz Curve (male wages at working age)

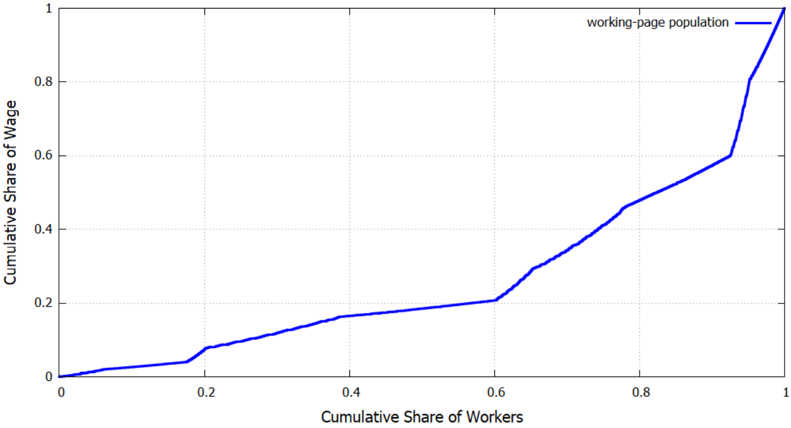

Figure: Lorenz curve of the wage distribution of the working-age male population (accounting for human capital, education and transitory shocks over the life cycle)

Benchmark: Life cycle profiles

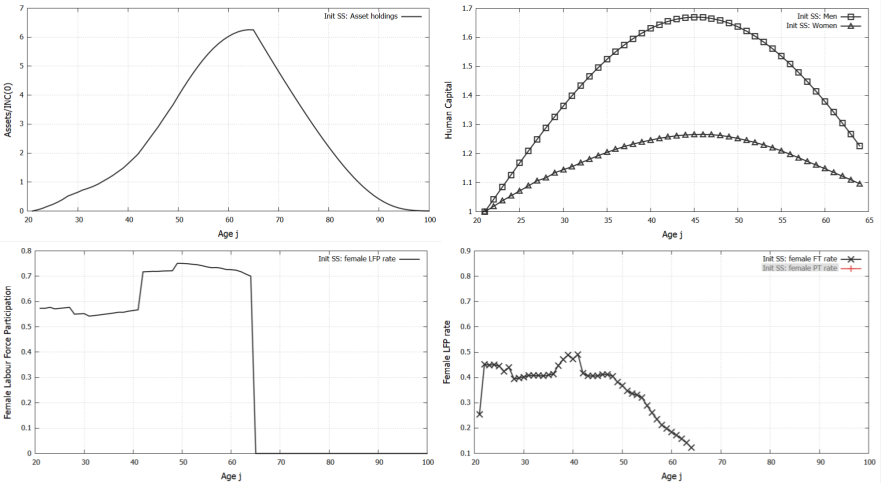

Figure: **Top left:** Assets-to-income ratio. **Top right:** Married male and female human capital. **Bottom left:** Female labor force participation rate. **Bottom right:** Female full time share of employment.

Results: Experiment set 2

	+50% FTB	+50% CCS	-50% FTB	-50% CCS
	Change	Change	Change	Change
Income (Y)	-1.11%	1.33%	1.09%	0.69%
Consumption (C)	-1.81%	2.05%	2.30%	-0.90%
Savings (S)	-3.75%	1.13%	4.22%	-2.11%
Female LFP	-3.48 p.p.	7.61 p.p.	6.83 p.p.	-4.31 p.p.
Female FT rate	-1.85 p.p.	4.29 p.p.	5.51 p.p.	-1.95 p.p.
Income tax rate	1.48%	0.61%	-1.15%	-1.08%
Tax revenue	4.52%	5.31%	0.33%	-3.72%
FTB expense	49.90%	-14.24%	-49.34%	4.88%
CCS expense	-12.12%	75.38%	37.40%	-60.00%
Pension	-0.31%	1.31%	0.11%	1.31%
HEV (newborn)	0.83%	0.1%	-1.00%	-0.3467%

Table: Changes relative to benchmark values

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Computing the Steady State: Algorithm (1)

We solve the benchmark model (*small open economy*) for its initial balanced-growth path steady state equilibrium.

1. Parameterize the model and discretize assets on $[a_{min}, a_{max}]$ such that:
    - Number of grid points, $N_A = 70$;
    - $a_{min} = 0$ (No-borrowing constraint);
    - The grid if fairly dense near a_{min} so households are not restricted by an all-or-nothing decision;
    - a_{max} is sufficiently large so that (i) *households are not bound by* a_{max}, and (ii) *there is enough room for upward movement induced by new policy regimes*.

    and for human capital grids on $[h^f_{min}, h^f_{max}]$:
    - Number of grid points, $N_H = 25$;
    - $h^f_{min} = h^m_{j=21} = 1$;
    - $h^f_{max} = h^m_{j=50} = 1.546$;

Computing the Steady State: Algorithm (2)

2. Guess K_0 and L_0, endogenous government policy variables, and w_m, taking $r = r^w$ as given;

3. Solve the firm's problem for (w_m, w_f);

4. Given the factor prices (w_m, w_f, r) and the initial steady state vector of parameters (Ω_0), solve the household problem for decision rules on $\{a^+, c, l^f\}$ by backward induction (from $j = J$ to $j = 1$) using *value function iteration*;

$w_m = w_f = w$ in this basic version of our model.

Computing the Steady State: Algorithm (3)

5. Starting from a known distribution of newborns, compute the measure of households across states by forward induction, using
   - the computed decision rules,
   - ψ,
   - η and its Markov transition probabilities, and
   - the law of motion of female human capital (1).
6. Accounting for the share of alive agents, sum across states for aggregate variables: A, C, L, T and Tr. Update L, K, I and Y (convex update). Solve for endogenous government policy variables.

Computing the Steady State: Algorithm (4)

7. Given the updated variables, compute the goods market convergence criterion for a small open economy:

$$Y = C + I + G + NX$$

   - $B_F = A - K - B$;
   - $NX = (1 + r)B_{F,t} - (1 + n)(1 + g)B_{F,t+1}$;
   - $NX < 0$ implies a capital account surplus (increase in foreign indebtedness).

8. Return to step 3 until the convergence criterion is satisfied.

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