Aggregate Implications of Child-Related Transfers with Means Testing*

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Abstract

This paper studies implications of child-related transfers with means testing for female labor supply, macroeconomic aggregates and welfare. We provide new insights from a macroeconomic analysis of two highly targeted child-related transfer programs in Australia: Family Tax Benefit (FTB) and Child Care Subsidy (CCS). We begin by documenting key life-cycle facts on child-related transfers, labor supply, wages and earnings in Australia. Next, we formulate a dynamic general equilibrium heterogeneous-agent overlapping generations model of single and married households who face income risk, lifetime uncertainty, costs of raising children and unequal access to child-related transfers due to means testing. Our quantitative analysis indicates that means testing is an important policy tool to better direct benefits to poorer households and to better manage public funding costs by controlling the conditions for receiving benefits (extensive margin) and the benefit level (intensive margin). However, the entailing high effective marginal tax rates imposes significant adverse effects on work incentive of mothers. Relaxing the means testing rule induces more female labor supply and human capital accumulation, which subsequently leads to aggregate efficiency gains and welfare improvement. Our results also highlight the importance of accounting for family structure, life-cycle dynamics and interplay between transfer programs in the general equilibrium setting when quantifying the resultant aggregate-welfare effects of a child-related transfer policy reform.

JEL: E62, H24, H31

Keywords: Child-Related Transfers, Means-Testing, Female Labor Supply, Dynamic General Equilibrium

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1 Introduction

Governments across advanced economies have policies that aim to support the well-being of low income families with dependent children, but designs of these child-related transfer programs can differ greatly and continue to be a part of an active policy debate. There are important policy questions concerning how a design of child-related government transfers affects female labor force participation, macroeconomic aggregates and welfare. Guner, Kaygusuz and Ventura (2020) study these questions in the context of the U.S. policy settings in which child-related transfers are relatively small, hovering around 0.7% of GDP.[1] Different from the US and many other countries, Australia devotes a significant portion of public funds - between 2-3% of aggregate output - to this cause. Its welfare expenditure on families and children alone account for 2.5 of GDP in the 2009-10 financial year. Importantly, child-related transfers in Australia are relatively more generous and highly targeted using a range of strict means-testing rules. There are two main programs: Family Tax Benefit (FTB) and Child Care Subsidy (CCS). The FTB is family-income means-tested, conditional on number and age of children, but not on labor market participation. Meanwhile, the CCS subsidizes the cost of formal child care services using means testing of family income and work hours. The means testing tool plays a crucial role in directing benefits towards low income families (i.e., extensive margin) and controlling the level of benefit payments (i.e., intensive margin). In this paper, we provide new insights through the Australian experience of implementing these child-related transfer programs concurrently. In particular, we aim to address two broad key questions: (i) What are the implications of means-testing child-related transfers? More precisely, how do transfer parameters in such complex programs affect the macroeconomic aggregates? (ii) Are there improving reforms either from efficiency or welfare perspective or both, and if so, what do they look like?

For this purpose, we first document the key life-cycle facts on child-related transfers, labor supply, wages and earnings in Australia. We highlight three key facts: (i) the importance of child-related transfers for poorer households; (ii) distinct shapes of life cycle labor supply of mothers; and (iii) gaps in labor supply, wages and earnings of parents and non-parents. We next build a structural model for quantitative analysis. Specifically, this study builds on Guner, Kaygusuz and Ventura (2021) and develops a dynamic general equilibrium overlapping generations (OLG) model of single and married households who face income risk, lifetime uncertainty, costs of raising children and unequal access to child-related transfers due to means testing. In the model economy, households are heterogeneous in terms of marital and parental status, number of children, education level, human capital, uninsurable income shocks, asset holdings, and government transfers. Married households make joint decision on female workforce participation, consumption and savings over the life-cycle. There are two government transfer programs that support households with children, the FTB and the CCS. We discipline our benchmark model to macro aggregates and household microdata from Australia.

The calibrated benchmark economy then allows us to conduct a series of counterfactual analyses. In each new counterfactual consideration, we vary policy parameters related to one or both of the child-related transfer programs and use labor income tax as a budget-balancing variable, while holding other policy parameters, government debt and general expenditure (net of child-related transfers and age pension) at the initial steady state levels. Our main results are summarized as follows.

First, we show that even in a complex transfer design, means-testing is an effective tool in manag-

[1] See the OECD data on family benefits public spending.

ing transfer program expenditure. Across the different benefit taper (or withdrawal) rates examined, altering means-testing parameters (income test thresholds) lead to comparable changes in the total program spending as those achieved through altering the payment rates of the program. Strict means testing also results in significant adverse effects on female work incentive, though there are exceptions arising from the inclusion of family structure and inelastic male labor supply. In most cases, however, relaxing the current means testing rule induces more female labor supply and human capital accumulation, which subsequently leads to aggregate efficiency gains and welfare improving.

Second, insightful results concentrate in the interplay between the incentive effects of the two child-related transfers. The FTB discourages female labor force participation, whereas the CCS does the opposite. A reduction to the size of one program therefore results in an expansion of the other if left unhindered. This interaction lessens the reform effect on the income tax burden, and therefore, the second-order effects that arise because of the change in tax rate. Due to this policy interaction, our model suggests that a world with these policies enacted has more female workforce participation but fewer women in full-time employment relative to a counterfactual child-related-policy-less world. Furthermore, we show that the latter is not necessarily better off efficiency-wise. Hence, of particular relevance to the policy making sphere is that our findings promote a holistic consideration that incorporates the interplay between policies, and its efficiency and welfare implications when analyzing a reform.

Third, life-cycle dynamics, family structure and family insurance are key determinants of reform effects on the aggregate statistics. A regime shift in our model can give rise to different efficiency and welfare outcomes from a model in which these life-cycle and family features are muted. Consider the following finding. Means tests impose substantial work disincentive effects and relaxing the income test thresholds will generally lead to greater female workforce participation, and vice versa.[2] However, when family or male primary earner's income is subject to means tests, a married woman's work decision alone has less influence on the eligibility and amount of benefits claimable. In such scenarios, tightening the thresholds does not necessarily lower labor force participation for women. Similarly, welfare outcome - measured by Hicksian Equivalent Variation (HEV) - of a reform is influenced by family structure. Removing both the FTB and the CCS generates substantial ex-ante welfare loss (i.e., welfare loss for newborn households under the veil of ignorance) amount to 51.5% in consumption term. Such a drastic drop arises because our simulated economy accounts for single mothers who have no family insurance and have limited ability to self-insure due to the time and pecuniary penalty of child care. With regards to the influence of life-cycle dynamics on a reform outcome, consider the efficiency effect which is linked to the life-cycle path of human capital. A decline in output is not just a result of lower participation but also lower human capital. All else constant, a policy that disincentivizes work for the young thus has a stronger adverse efficiency effect. This is a direct

[2]The general pattern we observe is that married mothers - who make up the majority of women - are most sensitive to reforms, whereas single mothers typically stick to part-time work and are much less responsive. At least within our setting, there are a few factors driving this outcome. First, the presence of inelastic spousal labor supply and time cost of child care keeps a significant fraction of married women in part-time work or off the labor force. A compounding factor for low-skilled (low education) women specifically is the early arrival of children. Consequently, married women have a weaker labor market tie and are more susceptible to the incentive effect of welfare programs. Second, assortative mating is a model feature that affects work decision. A low-skilled woman is always matched with a low-skilled man. Their combined household income tends to be smaller and permits larger benefits should the woman choose to stay at home. Last, single mothers have to contend with large trade-offs, and therefore are less free to switch between choices. If they work full-time, they incur high child care cost. If they stay at home, then lifetime consumption decreases because child-related benefits taper down as children grow older and their time away from work translates into loss of human capital potential.

consequence of the hump-shaped age-profile of human capital which implies greater human capital accumulation rates at early age.

Last but not least, our work sheds light on possible reforms according to either efficiency, welfare, or balanced objective. On these grounds, we rule out the complete removal of child-related transfers as it would lead to smaller female employment and output, and a drastic decline in welfare of newborn households. At least within the confines of our model, there are potential reform paths that could lead to improvement. Maintaining the CCS means-testing parameters (i.e., taper rates and income test thresholds) and all the FTB parameters at the status quo, raising the CCS subsidy rates is a well-rounded option in terms of efficiency and welfare. If one wishes to walk a different route by modifying the FTB means-testing parameters, lowering the FTB taper rates will ensure that at least one of the objectives is achieved. However, if the only feasible reform is through the CCS means-testing parameters (e.g., for political reasons), we find that this path brings about trivial changes to welfare provided that the FTB scheme is held in place. Here, efficiency consideration should take priority, and the model recommends scaling up the CCS income test thresholds.

Related literature. This paper is related to a wealth of literature studying the role of government insurance in heterogeneous-agent models accounting for family structure. Among others, Guner, Kaygusuz and Ventura (2012*a*) and Guner, Kaygusuz and Ventura (2012*b*) model economies with joint labor supply of married couples to study the disincentive effect of joint-taxation in the US and find that a more proportional separate filing system has favorable macroeconomic effects. In the same vein, Bick and Fuchs-Schündeln (2017) use a similar framework to quantify the effect of income and consumption tax differences on the cross-country married men's and women's work hour differences across 17 European countries and the US. A few recent studies (e.g., Kaygusuz 2015, Nishiyama 2019 and Borella, Nardi and Yang 2020) explore the efficiency and welfare impacts of the US's spousal and survival benefits using variants of the general equilibrium life-cycle model with two-earner households and marriage type. These studies converge on the conclusion that the marriage-related social security transfers welfare from two-earner to single-earner households, and are in favor of its elimination.

Another related body of work focuses on old-age pension. Braun, Kopecky and Koreshkova (2017) employ an OLG model with heterogeneity in gender, marital status, and education. They find that the welfare gains from means-testing social insurance for retirees are large, and that using a payroll tax to expand the existing programs in the US by 1/3 would benefit both the poor and the rich. Tran and Woodland (2014) construct a small open economy general equilibrium OLG model with households heterogeneous in skill, age, ability and assets to study the Australian means-testing age pension. Their results suggest that combinations of the maximum pension benefits and taper rates can be used to balance the insurance and incentive trade-offs of the age pension design. We demonstrate a similar mechanism at work for the means testing rule of child-related transfer programs.

Under this overarching structure, our paper contributes to a strand of literature on child-related government transfers. Guner, Kaygusuz and Ventura (2020) evaluate the effects of child care transfers in the US using a model with labor decisions, skill losses for women due to non-participation and heterogeneous fertility. They find that expanding work conditional transfers have positive effects on female labor supply and generates substantial ex-ante welfare gains. In terms of methodology, most similar to our work is Guner, Ventura and Kaygusuz (2019) who employs a life-cycle model with incomplete markets, two-earner households, costly children, and detailed tax and transfer schemes.

As in our study, heterogeneity related to marital status, skill, and parenthood plays a key role in their framework. However, they study multiple welfare programs and tax credit provisions in the US, and two possible reforms: Universal Basic Income (UBI) and Negative Income Tax (NIT). Their results suggest that the UBI is an inferior alternative, whereas lower distortions associated with the NIT enable larger redistribution and can improve upon the status quo. Differently, we employ a similar construction to investigate how (i) each individual means-testing policy targeting children and families of limited means, and (ii) the interaction between these policies directly and indirectly affect household decisions, and ultimately, the efficiency and welfare outcomes. More specifically, our research contributes to the literature in two important aspects. First, we put a spotlight on the interplay between different social security programs with some objectives counteracting each other. Our findings reveal how economic outcomes brought about by their intermingling can differ from the ones expected of their isolated individual effects. Second, we conduct a large set of experiments on key means-testing parameters and benefit payment rates in a rich model environment with earnings and mortality risks, life-cycle dynamics, costly children and family structure. As in Guner, Kaygusuz and Ventura (2020), we recommend expanding the work conditional program (the CCS) to improve welfare. At the same time, our model suggests that improving both efficiency and welfare is possible for the Australian context.

Our work thus provides new insights through the lens of Australian child-related transfer programs, and is a part of the growing research body on the impacts of fiscal policy in Australia (e.g., see Tran and Woodland 2014, Kudrna, Tran and Woodland 2022 and Tin and Tran Forthcoming 2023). Different from previous studies, we model family structure (e.g., single and married parent households with dependent children), life-cycle factors (e.g., child-bearing and child-rearing stage, age-varying human capital accumulation potential, and mortality risks), and other demographic characteristics (e.g., education/skill). The quantitative results uncovered enrich the knowledge on efficiency and welfare effects of the Australian child-related policies, and provide important lessons for countries looking to pursue similar means-testing design.

The paper hereinafter proceeds as follows. Section 3 gives a full description of the model environment. Section 4 reports the internal and external calibration procedures, and the performance of the calibrated benchmark economy. Section 5 presents counterfactual analyses on means-testing parameters, and Section 6 discusses additional results. Section 7 concludes. Appendices provide detailed information on the two child-related transfer programs, the computational algorithm to solve the model, and additional statistics and results.

2 Child-related transfers and life-cycle facts in Australia

In this section, we provide brief institutional features of child-related transfer programs in Australia and selected empirical life-cycle facts of Australian individuals and households.

2.1 Child-related transfers in Australia

Child-related transfer programs in Australia are highly targeted with emphasis on supporting low-income single-earner parents through a range of instruments such as strict means-testing measures on either joint income or income of the secondary earners, and adjustable payment rates and income test thresholds that scale with the number and age of dependent children. There are two major programs:

Family Tax Benefit (FTB) and Child Care Subsidy (CCS), both of which are means-tested, and conditional on the number and age of children. The FTB, a direct lump-sum transfer, does not depend on labor market participation and consists of two parts. The FTB part A tests joint income. The FTB part B tests primary earner's income to determine eligibility (extensive margin) and tests secondary earner's income to determine the benefit amount and clawback (intensive margin). The per child maximum and base payments are at their highest for households with young children. The CCS program, on the other hand, subsidizes the cost of formal child care services using means test on joint family income. Unlike the FTB, the CCS is available only to households with children aged 13 or younger. More importantly, the key feature that distinguishes the CCS from the FTB is that it contains an activity test on the secondary earner's work hours to adjust the rate of subsidy. Appendix A gives a more detailed description of the two programs, who qualifies and how the benefits change in relation with marital status, parental status, number and age of children, and household income.

2.2 Data and summary statistics

We use data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey Restricted Release 20 (2001 − 2020). Began in 2001 and has since been conducted on an annual basis, HILDA is a nationally representative panel data of Australian households on a wide range of subjects pertaining to family and labor market dynamics. The survey collects information on respondents and their family members, including demographics, earnings and their sources, taxes and transfers, household and family identifiers, and a rich set of covariates.

We document aggregate and life-cycle facts on labor earnings, total income, government transfers, hourly wages, hours worked and labor force participation for individuals by gender, marital status and parental status. These serve as motivating factors and evidence to support our quantitative findings and subsequent discussion.

Table 1 presents descriptive statistics for age, usual weekly hours, weekly wages, and selected income and transfer variables at individual and family levels in 2020.

Primary Earner		N	Mean	Median	SD	Min	Max
Age	Individual	5,064	41.62	40	11.42	25	64
	Family	5,064	-	-	-	-	-
Weekly hours	Individual	5,064	38.39	40	12.17	0	137
	Family	5,064	53.17	48	30.83	0	227
Weekly wages	Individual	5,064	1,602.68	1,407.68	994.18	0.00	13,106.03
	Family	5,064	2,366.64	2,135.80	1,479.03	0.00	15,752.48
Labor Income	Individual	5,064	85,855.68	75,723.73	56,891.76	0.00	970,817.13
	Family	5,064	129,099.10	114,556.42	85,839.93	0.00	1.13e+06
Market income	Individual	5,064	88,836.96	77,665.37	60,488.81	-42,502.38	970,817.13
	Family	5,064	139,555.66	121,949.19	102,986.36	-42,016.96	2.74e+06
Private transfer	Individual	5,064	446.73	0.00	3,197.68	0.00	132,911.66
	Family	5,064	809.84	0.00	5,273.85	0.00	168,922.17
Total income tax	Individual	5,064	20,926.39	15,641.81	23,154.97	-2,259.09	413,873.91
	Family	5,064	31,058.35	23,178.26	37,202.65	-7,960.70	1.16e+06
Public transfer	Individual	5,064	2,133.53	0.00	5,764.68	0.00	72,231.70
	Family	5,064	5,205.20	0.00	10,679.92	0.00	97,191.41

Table 1: **Summary statistics of primary earners in financial year 2020**. The values of income, tax liabilities and transfers are expressed in 2018 AUD.

2.3 Life-cycle facts

The key empirical life-cycle facts that emerge from our empirical analysis are listed below.

Fact 1: Child-related transfers are important sources of income for poorer households

- Table 2 and Figure 2 show that family transfer (most of which is child-related) is large and makes up more than half of the total public transfer for households in the bottom quintile. More importantly, the table suggests that the scheme is highly targeted, not just with respect to income level but also parenthood. Parents are able to claim substantial benefit, whereas non-parents of the same income bracket receive a trivial amount. Parents in the second, third and fourth quintile, for instance, receive approximately three-fourth of their public benefit as direct family transfer.

- Zooming in and breaking down each group by gender and marital status for the first three quintiles, Table 3 suggests that even among parents, the family transfer design places emphasis on marital status of parents. Among the recipients, single households get about as much benefit as married households do.

- Figure 1 further reiterates two important life-cycle facts. First, the FTB shares of gross total income for the first three quintiles are at their largest during the phase of life most occupied by child-bearing and rearing obligations. For the poorest household, in particular, the FTB part A and part B at their peak makes up over 40% of their gross total income. For parents in particular, the age-profiles in Figure 2 indicates that the FTB benefits in 2018 (the gap between post-tax income and post-FTB income) for the first and second quintile comprise half of the total government transfer consistently throughout their life-cycles. The poorest below age 40 receives on average 10 thousand dollars (AUD in 2018) while their market income is virtually naught. In both relative and absolute senses, the average FTB transfer for low income households during the 20 years of observation was significant, and it begs the question of how this might have impacted their work decisions.

		Age	Higher Education	Hours (Weekly)	Wage (Weekly)	Market Income (Annual)	Family transfer (Annual)	Total public transfer
1	Parent	37.04	53	25.06	431.39	8,065.76	16,046.15	29,628.35
	Non-parent	34.1	41	25.25	439.94	9,241.95	74.57	8,113.97
2	Parent	38.47	59	34.15	717.34	35,792.25	14,304.55	19,174.27
	Non-parent	37.76	52	35.53	786.26	38,842.94	69.61	2,309.72
3	Parent	39.16	65	37.31	981.51	53,330.45	7,588.87	9,119.27
	Non-parent	39.18	61	38.96	1,049.88	57,771.13	72.01	1,052.07
4	Parent	41.04	71	38.41	1,269.71	71,613.00	2,800.09	3,611.17
	Non-parent	39.5	66	40.48	1,220.94	69,634.42	72.65	585.03
5	Parent	43.81	83	40.67	1,893.70	130,694.33	492.86	956.73
	Non-parent	40.43	71	41.90	1,619.62	106,837.39	57.10	452.90

Table 2: **Average 20-year statistics for parents and non-parents by family market income quintile. All income and transfer values are stated in 2018 Australian dollar.**

				Age	Higher Education	Hours (Weekly)	Wage (Weekly)	Market Income (Annual)	Family transfer (Annual)	Total public transfer
1	Parent	Female	Married	37.76	0.52	21.93	351.95	8,606.07	16,562.07	30,488.53
			Single	35.91	0.53	19.57	394.15	8,405.73	15,543.54	28,452.93
		Male	Married	37.67	0.53	35.78	549.33	7,131.24	16,822.63	31,531.71
			Single	42.35	0.65	25.38	377.37	8,391.72	13,723.69	25,218.91
	Non-parent	Female	Married	42.61	0.39	21.95	330.23	9,698.18	115.37	14,455.51
			Single	32.33	0.44	21.79	412.72	9,458.34	64.40	6,671.70
		Male	Married	41.28	0.47	31.44	439.17	8,269.99	110.10	12,362.00
			Single	31.36	0.37	27.99	500.43	9,154.35	62.90	6,505.85
2	Parent	Female	Married	37.86	0.57	24.50	511.58	22,245.91	13,634.21	18,460.58
			Single	40.06	0.64	30.23	757.21	39,957.50	13,510.48	18,351.28
		Male	Married	37.42	0.56	41.73	797.82	39,914.17	15,323.38	20,368.44
			Single	43.37	0.68	37.42	800.88	43,748.14	12,354.30	15,386.13
	Non-parent	Female	Married	41.28	0.50	28.77	598.87	27,740.26	104.54	5,312.39
			Single	37.92	0.58	34.30	835.51	41,945.45	53.59	1,266.48
		Male	Married	41.21	0.54	37.05	701.84	33,829.79	99.60	4,388.38
			Single	34.76	0.47	38.68	854.82	42,739.62	56.76	1,127.53
3	Parent	Female	Married	38.02	0.60	26.88	668.60	33,180.32	6,801.65	8,286.84
			Single	43.16	0.76	39.04	1,315.33	72,731.73	8,649.18	10,034.78
		Male	Married	39.14	0.66	44.55	1148.70	64,326.80	7,995.68	9,610.52
			Single	45.66	0.73	43.30	1,349.86	79,314.12	8,031.67	8,791.40
	Non-parent	Female	Married	39.53	0.59	32.96	804.86	42,424.30	96.00	1,552.06
			Single	39.82	0.72	38.91	1,213.76	67,857.61	44.65	579.33
		Male	Married	41.33	0.60	41.16	1,000.81	55,191.77	90.46	1,404.99
			Single	35.72	0.58	43.09	1,250.76	69,903.43	45.26	453.81

Table 3: **Average 20-year statistics by family market income quintile and key demographics (gender, marital status and parenthood) for the bottom 3 quintiles. All income and transfer values are stated in 2018 Australian dollar.**

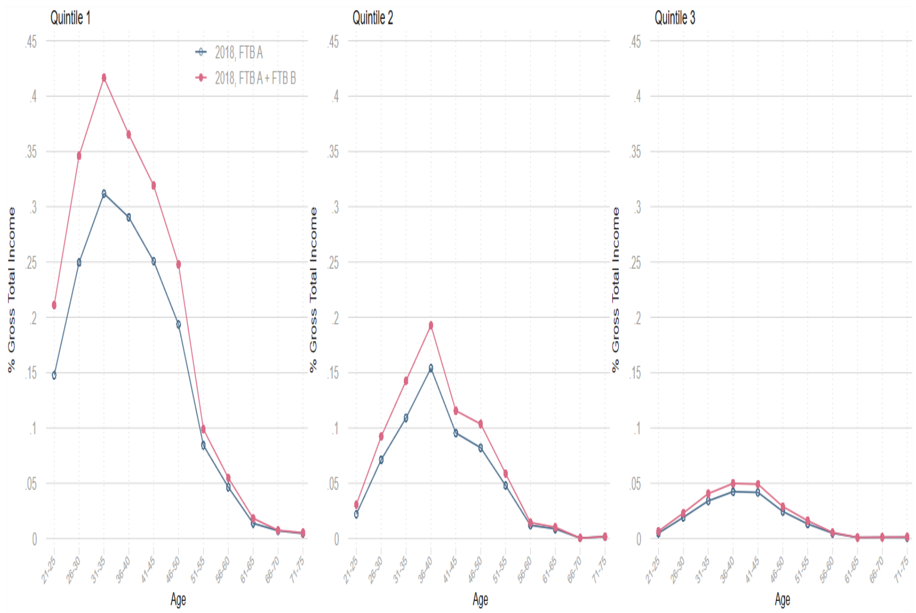

Figure 1: **Age profiles of FTB share of income for the bottom three quintiles.**

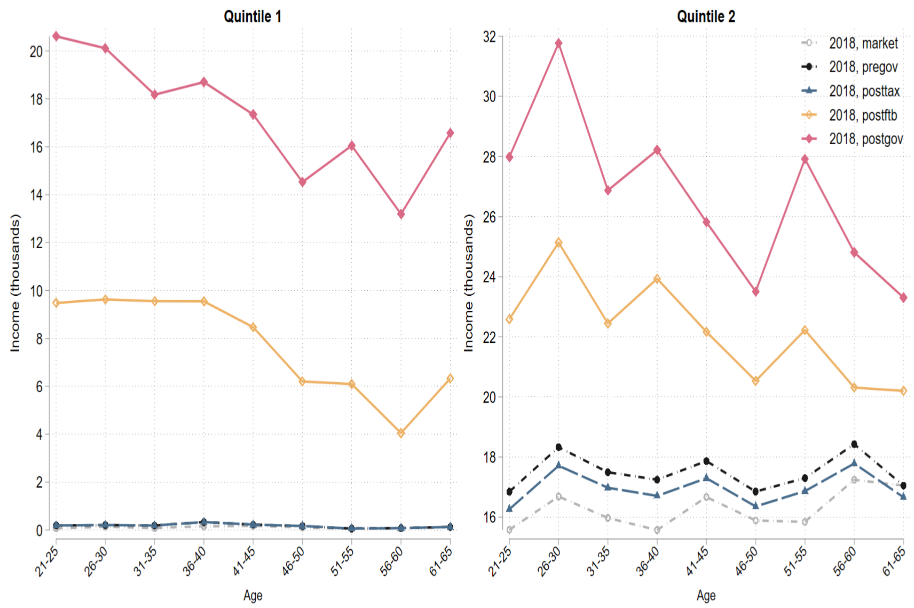

Figure 2: **Age profiles of income at different levels for parents in the bottom two quintiles of pre-government income.**

Notes: Pre-government income (black line) is a combined income from all market sources and private transfer before tax and public transfer. Post-tax income (blue line) is pre-government income net of tax and concessions. Post-FTB income (orange line) adds the FTB part A and part B to the post-tax income. Post-government income (a.k.a. post-fiscal or disposable income) is a sum of the post-FTB income and other public transfers received for the completed financial year preceding the date of HILDA survey interview.

Fact 2: Distinct shapes of the life-cycle labor supply of mothers We calculate total earnings, hours and hourly wage rates for individuals in the sample, and find that the age profiles of labor supply exhibit striking differences between parents and non-parents.

- **Work hours (intensive margin of labor supply)**: Figure 2.3 and 4 are complementary and tell an important story of work hours. Figure 2.3 alone shows two noteworthy points. First, we see similar hump-shaped life-cycle trajectories of work hours between partnered (left panel) and single men (right panel), though the latter group appears to be at a slightly lower level mid-life. Second, while women in general work less than men do, single and married women differ dramatically in terms of their life-cycle profiles of work hours. Married women have a very distinct M-shaped profile, whereas single women's profile is almost flat between age 30 and 60 with only slight recession in the middle. These two demographics begin with similar average hours at early age. However, married women undergo precipitous decline just before they reach 30 years of age, and by the age of 40, they spend only about 30 hours per week in paid jobs. That is, they work on average 5 hours less than single women and 15 hours less than married men. They recover slowly afterwards but never get to the same height as when they were young. Figure 4 reveals that factors associated with parenthood are likely the driving mechanism. First is the fact that the there is a significant drop in participation for both single and married women (second column of Figure 4) relative to childless women (first column). The latter group has more stable hump-shaped profiles hovering above 40 hours per week, comparable to those of men. Second, Figure 4 also shows sign of slower work hour growth for married mothers compared with their single counterparts. The interaction of factors associated with parenthood and marriage might play a role in slowing down the intensive margin adjustment of labor supply for married mothers. More precisely, there might be links between childcare responsibilities, family structure and large government transfers targeting parents shaping the life-cycle features we observe. For instance, family insurance via spousal earnings could impact the labor supply decision of mothers and prolongs the duration they spend out of the workforce.

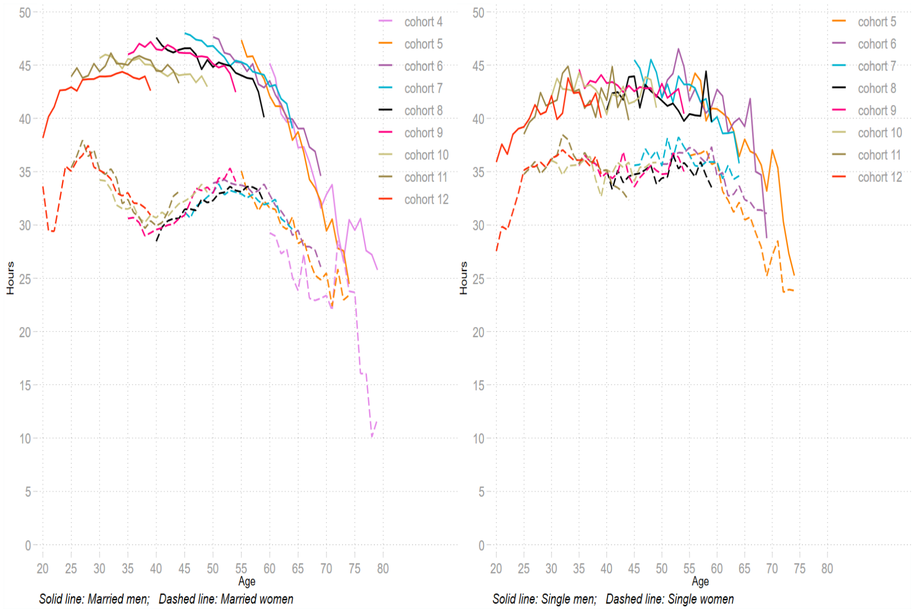

Figure 3: Age profiles of work hours (if employed) by marital status and gender. Left panel: married men (solid line) and married women (dashed line). Right panel: single men (solid line) and single women (dashed line).

Notes: The age profiles stitch together 20-year snapshots of life-cycle for selected cohorts. The youngest cohort is cohort 12 aged 20-39 in the data. The oldest cohort is cohort 4 (aged 60-79) on the left panel and cohort 5 (aged 55-74) on the right panel. We omit the very old cohorts due to data limitation.

- **Labor force participation (extensive margin of labor supply)**: As in the case of work hours, similar behavior is evident in Figure 5. Participation rates for men and childless women, whether single or married, stay above 80% for most of their working age. Notably, more than 90% of married men stay in the workforce until around age 55 when their participation rate begins to fall. In contrast, only 50% of partnered and single mothers aged 30 are part of the labor force. Their participation rates follows a hump shape, rises rapidly to roughly 80% by the age of 50 and falls back just as rapidly afterwards. Interestingly, the qualitative pattern associated with work hours and parenthood holds true for full-time employment share. In Figure 6, men and childless women experience similar life trajectories; meanwhile, the fractions of employed single and married mothers in full-time work are significantly smaller by comparison. The patterns observed in Figure 6 also suggest that the factors related to parenthood and marriage discussed previously could have been part of the reasons behind the slower recovery rate of married mothers relative to single mothers.

Fact 3: There are big gaps in wages and earnings between parents and non-parents

- Based on Figure 7, hourly wage measures of normalized returns to labor over life-cycle display striking resemblance across gender and marital status for non-parents. The main differences are

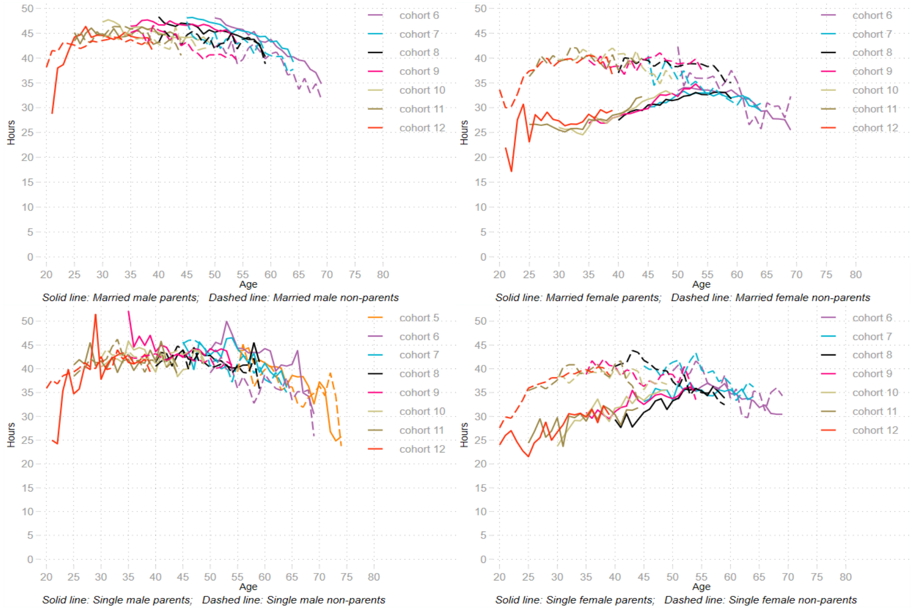

Figure 4: **Age profiles of work hours (if employed) by key demographics (gender, marital status and parenthood). Top left:** married fathers (solid) and married childless men (dashed). **Top right:** married mothers (solid) and married childless women (dashed). **Bottom left:** single fathers (solid) and single childless men (dashed). **Bottom right:** single mothers (solid) and single childless women (dashed).
Notes: The age profiles stitch together 20-year snapshots of life-cycle for selected cohorts. The youngest cohort is cohort 12 aged 20-39 in the data. The oldest cohort is cohort 6 (aged 50-69), except for the bottom-left panel in which the oldest is cohort 5 (aged 55-74).

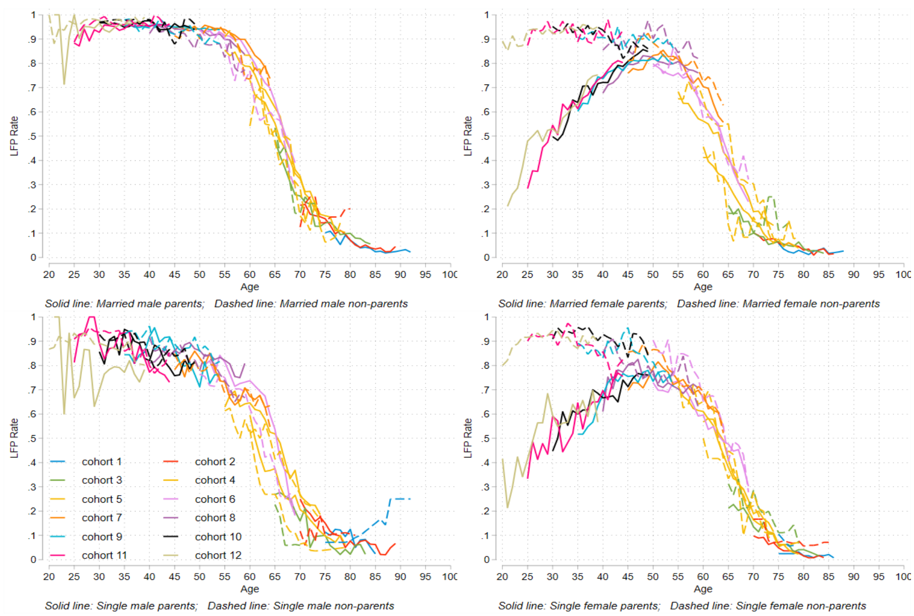

Figure 5: **Age profiles of labor force participation by key demographics (gender, marital status and parenthood). Top left:** married fathers (solid) and married childless men (dashed). **Top right:** married mothers (solid) and married childless women (dashed). **Bottom left:** single fathers (solid) and single childless men (dashed). **Bottom right:** single mothers (solid) and single childless women (dashed).
Notes: The age profiles stitch together 20-year snapshots of life-cycle for selected cohorts. The youngest cohort is cohort 12 aged 20-39 in the data, and the oldest cohort is cohort 12 aged 75-94.

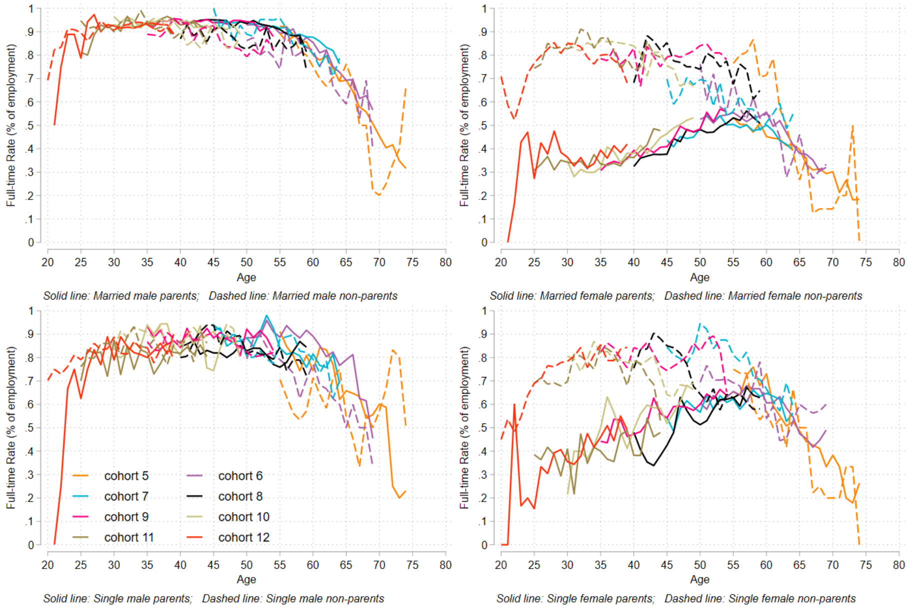

Figure 6: **Age profiles of full-time share of employment by key demographics (gender, marital status and parenthood). Top left:** married fathers (solid) and married childless men (dashed). **Top right:** married mothers (solid) and married childless women (dashed). **Bottom left:** single fathers (solid) and single childless men (dashed). **Bottom right:** single mothers (solid) and single childless women (dashed).
Notes: The age profiles stitch together 20-year snapshots of life-cycle for selected cohorts. The youngest cohort is cohort 12 aged 20-39 in the data, and the oldest cohort is cohort 5 aged 55-74.

between (i) parents and non-parents, and (ii) fathers and mothers (regardless of their marital status). Non-parents experience similar wage profiles whether they are single or married, male or female. The differences between parents and non-parents are however notable. Compared with parents, the average non-parents start with lower wages that increase rapidly to surpass parents by age 30 for a brief period and then proceed to decline at a greater rate. Among parents, hourly returns are significantly lower for mothers, especially if they are married. Fathers, on the other hand, have more stable life-cycle wage profiles that are generally the highest when compared with other groups. As in the cases of work hours and participation, the evidence suggests that parenthood is correlated either directly (e.g., childcare responsibilities) or indirectly (e.g., spousal earnings, child-related transfers, and demand side factors such as occupational choice and institutional structure, etc) with the wage differentials.

- The joint effects of wage and hour gaps over the life-cycle result in age-profiles of earnings in Figure 8. Non-parents have comparable hump-shaped age profiles. While childless women earn less than their male counterparts do over the life-cycle, the gap is small. The greatest difference is between mothers (single or married) and the rest of the group (i.e., both their male and childless female counterparts). Due to the combination of lower wages and labor supply (hours and participation) throughout most of their prime-working age, their average weekly earnings by age 40 amounts to half the earnings of men of the same age.

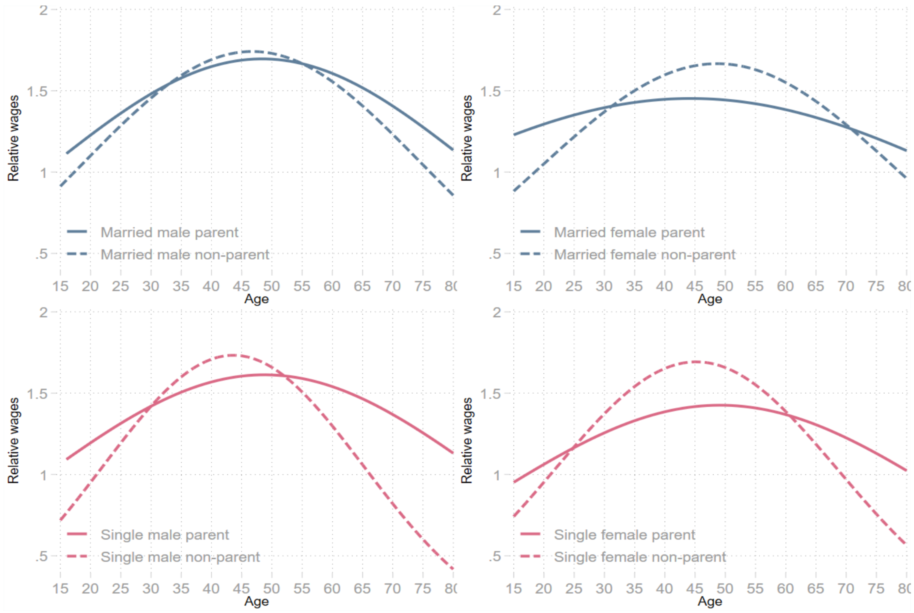

Figure 7: **Age profiles of normalized wages (against age-21 worker's average wages) by key demographics (gender, marital status and parenthood). Top left:** married fathers (solid) and married childless men (dashed). **Top right:** married mothers (solid) and married childless women (dashed). **Bottom left:** single fathers (solid) and single childless men (dashed). **Bottom right:** single mothers (solid) and single childless women (dashed).
Notes: Due to the lack of balanced panel data covering the entire lifespan of individual observations, the estimated wage figures are predicted values via a regression of log wages on quadratic age terms, gender, parenthood, marital status, the interactions between the selected demographics and age, and a year dummy.

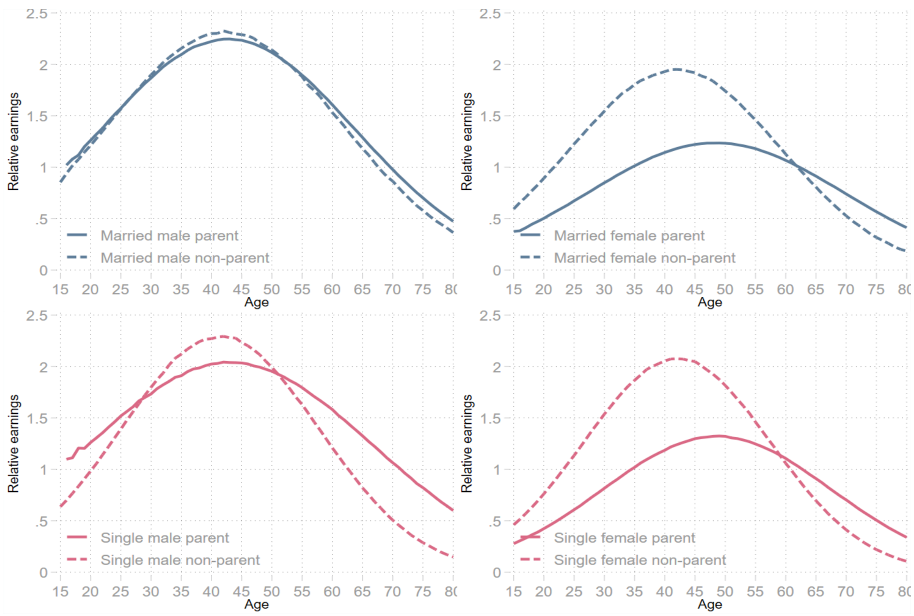

Figure 8: **Age profiles of normalized weekly earnings (against age-21 worker's average earnings) by key demographics (gender, marital status and parenthood). Top left:** married fathers (solid) and married childless men (dashed). **Top right:** married mothers (solid) and married childless women (dashed). **Bottom left:** single fathers (solid) and single childless men (dashed). **Bottom right:** single mothers (solid) and single childless women (dashed).
Notes: Due to the lack of balanced panel data covering the entire lifespan of individual observations, the estimated wage figures are predicted values via a regression of log weekly earnings on quadratic age terms, gender, parenthood, marital status, the interactions between the selected demographics and age, and a year dummy.

3 The model

We study a small open economy model populated by a continuum of overlapping generations households, a competitive firm with CRS technology, and a government who commits to balancing its budget every period. Time begins at $t = 0$ when the model economy is at initial steady state, and ends at $t = T$. One model period corresponds to one year. Because the FTB and the CCS concentrate in child-bearing and raising ages, this choice allows us to better capture behavioral responses to child-related policy experiments.

3.1 Demographics

There are three types of family structure (i.e., household types) assigned at birth to households in the model economy: (i) married parents ($\lambda = 0$), (ii) single childless men ($\lambda = 1$) and (iii) single mothers ($\lambda = 2$).[3] In model time, a new household of age $j = 1$ (real age = 21) is born every period t and retire at age of $J_R = 45$. The total number of new households at time $t = 0$ is normalized to one. The model population grows at a constant rate of n.

Evolution of household structure. The present model abstracts from divorce and marriage decisions. Households born single live a single life till death. Those born married comprise couples of the same age and skill whose evolution of marital status depends solely on survival probabilities. More precisely, every adult household member faces a mortality risk determined by their age j and gender $i \in \{m, f\}$. Each individual born in time t survives for an entire period $t+j-1$ with a time-invariant conditional probability $\psi_{j,i}$ and lives to the maximum age $J = 80$ (i.e., $\psi_{J+1,i} = 0$).[4] Consequently, following Nishiyama (2019), a married household will become single if one of the spouses dies before or at age 80. Using conditional survival probabilities, provided that the model family structure is marital status dependent, we can construct its transition probabilities over life-cycle ($\pi_{\lambda_{j+1}|\lambda_j}$) as

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

Table 4: Transition probabilities of family structure

Children. Parenthood is a definite stage of life for every woman in the model. Children are deterministic and exogenous as we abstract from fertility choice. Households possess full information on the arrival time of children, the time (non-pecuniary) and pecuniary child care costs per child, the FTB benefit per child, the CCS rate per hour worked, and the human capital gain (loss) if the mother works (stays at home). For simplicity, childcare quality and cost for a child aged j_c are exogenous and

[3] Share of newborn households by marital status is exogenously estimated (see calibration in section 4). For the current model, there are no childless couples. According to the 2016 Australian Census of Population and Housing, the most common family composition is coupled with children (45%) while childless couples account for (38%). For single households, we assign children only to single women. Our sample data (from HILDA survey) suggests that women constitute the majority (87.21%) of lone parents. This modeling choice could lead to the reform effect on labor supply being overstated given that non-parents are not the target beneficiary and are related to the FTB and the CCS only indirectly via the budget-balancing tax channel (or lumpsum transfer channel in an alternative government budget-balancing arrangement).

[4] More precisely, $\psi_{j,i}$ is the probability of an agent surviving the whole period $t+j-1$ conditional on having survived the previous period $t+j-2$. If an agent aged j did not survive to the next period, then all his gross assets earnings would become a part of the pooled accidental bequest to be uniformly distributed to alive working-age generations in period $t+j-1$.

identical for all households. There are no informal care and bequest motive in the model economy. Households are further assumed to have the same number of children, $\bar{nc} = 2$, over their lifetime. Child spacing is identical for all parents. However, the timing of birth varies by skill type. The firstborn arrives earlier for low education (θ_L) households and later for high education (θ_H) households.[5] Thus, the k^{th} child is born to every household aged $j = b_{k,\theta}$ and is dependent until the age of 18 (from $j = b_{k,\theta}$ to $j = b_{k,\theta} + 17$). Afterwards, they leave home for good and this marks the end of the parent-child link. With these simplifications, the number of children a household aged j type θ has is $nc_{j,\theta} = \sum_{k=1}^{\bar{nc}} \mathbf{1}_{\{b_{k,\theta} \leq j \leq b_{k,\theta}+17\}}$.[6]

This configuration allows for a more tractable and efficient algorithm. Since the number and age of children can be identified by the state variables, household age j and education (or permanent skill type) θ, no new state element is created. Furthermore, because the age and number of children - two key inputs to determine the extensive (eligibility) and intensive (amount claimable) margins of the FTB and the CCS - can be calculated using the existing state variables, the two programs can be integrated into the model without adding extra states. This significantly reduces computational cost by keeping the number of state elements necessary to fully describe the household problem in each model period unchanged even with the addition of children and two child-related transfer programs.[7]

3.2 Preferences

Every new household has preference represented by a time-separable expected utility function

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

where c_j is joint consumption, l_j^m is leisure time of the husband, l_j^f is leisure time of the wife, λ_j is the household type, nc_j is the number of dependent children, and β is the time discount factor. The periodic utility functions of single male and single female differ by the presence of dependent children exclusive to the latter. This choice is informed by our observation that about 88% of single parent households are female headed.[8] We assume spouses are perfectly altruistic towards one another and

[5] The terms '*education*' and '*permanent skill*' are used interchangeable in this paper.

[6] Note that, we assume children and population growth are detached. Children are regarded as an exogenous and deterministic life event for all couples and single mothers. In that sense, child care is exogenous and parents derive no utility from having children (this makes sense in the current context in which fertility is exogenous, and therefore making children affect utility of household is not a necessary feature). The resources allocated to the children upbringing also do not contribute to the productivity of the future labor force.

[7] There are multiple routes one can take in modeling children. One such route is to impose an exogenous age profile of the average number of children that households will have over life-cycle. However, this abstraction would not allow us to conduct detailed experiments on the impacts of policy and children (number and arrival time) on households without first estimating parametric functions for the transfer programs of interest for each type combination (e.g., education, marital status, age and number of children, etc). This demands a large dataset for reliability of estimation, and because our main analysis is performing policy experiments on the FTB and the CCS, such an approach renders the experiments harder to interpret. Another route is to model endogenous fertility choice. This is computationally expensive given the already high dimensionality of the problem. There is also evidence of weak correlation between child-related transfers and fertility. E.g., Bick (2016) finds that child care support does not increase fertility rate in Germany. For these reasons, the question of financial incentive and fertility is not addressed in this work. The method we adopt is used in Guner, Kaygusuz and Ventura (2012*a*, 2020) to model children, which places us between the two aforementioned alternatives. As explained, this approach comes at a relatively low computational burden and gives us enough room for detailed counterfactual experiments.

[8] If the female spouse dies in a married household, the present model does not allow the children to stay with the widowed father. Nonetheless, because (i) the majority of single parents are women, (ii) labor supply decisions in the model are restricted to women, and (iii) children only stay for 18 years with their parents, we believe the current setting comes with a small cost of realism but huge savings in computational time by not having to keep track of an additional

thus choose joint consumption, savings, and leisure for their entire household. The combined utility of a married household is just the sum of that of single male and single female types adjusted by their consumption equivalence , $ces(\lambda_j, nc_j) = \sqrt{\mathbf{1}_{\{\lambda_j \neq 1\}} + \mathbf{1}_{\{\lambda_j \neq 2\}} + nc_j}$. The periodic household utility function for each household type can be written as follows

$$
u(c_j, l_j^m, l_j^f, \lambda_j = 1, 0) = \frac{\left[\left(\frac{c_j}{ces(1,0)}\right)^{\nu}\left(l_j^m\right)^{1-\nu}\right]^{1-\frac{1}{\gamma}}}{1-\frac{1}{\gamma}} \tag{1}
$$

$$
u(c_j, l_j^m, l_j^f, \lambda_j = 2, nc_j) = \frac{\left[\left(\frac{c_j}{ces(2,nc_j)}\right)^{\nu}\left(l_j^f\right)^{1-\nu}\right]^{1-\frac{1}{\gamma}}}{1-\frac{1}{\gamma}} \tag{2}
$$

$$
u(c_j, l_j^m, l_j^f, \lambda_j = 0, nc_j) = \frac{\left[\left(\frac{c_j}{ces(0,nc_j)}\right)^{\nu}\left(l_j^m\right)^{1-\nu}\right]^{1-\frac{1}{\gamma}} + \left[\left(\frac{c_j}{ces(0,nc_j)}\right)^{\nu}\left(l_j^f\right)^{1-\nu}\right]^{1-\frac{1}{\gamma}}}{1-\frac{1}{\gamma}} \tag{3}
$$

where ν is the taste for consumption and γ is the elasticity of intertemporal substitution. The square root consumption equivalence scale, $ces(\lambda_j, nc_j)$, implies that the normalized or per family member consumption is a non-linear (convex) function of family size. For instance, a 4-member household with two adults and two children has an equivalence scale of $ces(2, 2) = 2$. That is, for a unit of total consumption c, the corresponding per capita consumption $\frac{c}{ces(2,2)} = 1/2$, instead of $1/4$. The scale helps account for shared consumption in the household (e.g., durable goods, bulk purchase, etc).[9]

3.3 Endowments

Married and single men. Men always work full time until retirement and earn labor income of $y_{j,\lambda}^m = w n_{j,\lambda}^m e_{j,\lambda}^m$ where w is market wage rate, and $n_{j,\lambda}^m$ and $e_{j,\lambda}^m$are exogenous male labor supply and earning ability for household type $\lambda \in \{0, 1\}$ at age j, respectively. The intensive margin of labor supply $n_{j,\lambda}^m = 1 - l_{j,\lambda}^m$ is set at the normalized values of average work hours over working age of married ($\lambda = 0$) and single male ($\lambda = 1$). The earning ability $e_{j,\lambda}^m$ can be decomposed into deterministic component $\bar{e}_j$ and stochastic shock component ϵ_j^m as

$$
e_{j,\lambda}^m = \bar{e}_j\left(\theta, h_{j,\lambda}^m\right) \times \epsilon_j^m,
$$

where $\bar{e}_j\left(\theta, h_{j,\lambda}^m\right) = \theta h_{j,\lambda}^m$ is a non-linear function of education level θ and male human capital, $h_{j,\lambda}^m$. θ takes on low (θ_L) or high (θ_H) value, is realized at birth, and is common to all adult members of a household by the assortative mating assumption. $h_{j,\lambda}^m$ differs by household type and evolves exogenously on a hump-shaped trajectory over age.

state, death of a spouse.

[9]The square root scale yields similar values to the OECD-modified scale and is easy to handle due to its functional form. For more information, visit the OECD's note on consumption equivalence scales.

The stochastic shock component ϵ_j^m is modeled as an auto-regressive process

$$\overbrace{\ln\left(\epsilon_j^m\right)}^{=\eta_j^m} = \rho \times \overbrace{\ln\left(\epsilon_{j-1}^m\right)}^{=\eta_{j-1}^m} + \upsilon_j^m, \tag{4}$$

with a persistence parameter ρ and a white-noise disturbance $\upsilon_j^m \sim N\left(0, \sigma_\upsilon^2\right)$.

Married and single women. In addition to consumption/saving decision, a household makes labor decision at the extensive margin for its female member on three discrete choices, $\ell \in \{0, 1, 2\}$. In particular, labor decision for women is concerned with whether to exit the labor force ($\ell = 0$), work part time ($\ell = 1$), or full time ($\ell = 2$). This decision is influenced by the act of balancing work-related trade-offs at the margin to achieve the household utility maximization objective. These trade-offs and their defining parameters, as described below, ultimately affect female labor supply behavior in the benchmark steady state economy, how susceptible they are to the insurance and incentive effects of the social security schemes, and thereby, how they respond to reforms in the counterfactual economies.[10]

The benefits of work. If a woman works, then she *(i) earns labor income* ($y_{j,\lambda}^f = wn_{j,\lambda,\ell}^f e_{j,\lambda}^f$), (ii) *accumulates human capital for the next period* ($h_{j+1,\lambda}^f$), and (iii) *obtain child care subsidy of* s_j *per child if she meets the eligibility criteria.* Because households only make participation decision, her age-profile of work hours, $n_{j,\lambda,\ell}^f$, is derived from estimates from the data, and is conditional on her labor choice ($\ell = 1$ or $\ell = 2$) and type ($\lambda = 0$ or $\lambda = 2$). Her earning ability is

$$e_{j,h}^f = \overline{e}_j\left(\theta, h_{j,\lambda,\ell}^f\right) \times \epsilon_j^f,$$

where ϵ_j^f is the stochastic component, and $\overline{e}_j\left(\theta, h_{j,\lambda,\ell}^f\right)$ is determined by the education θ and the human capital $h_{j,\lambda,\ell}^f$. As her male counterparts, the stochastic component ϵ_j^f is modeled as an auto-regressive process so that $\ln\left(\epsilon_j^f\right) = \rho \times \ln\left(\epsilon_{j-1}^f\right) + \upsilon_j^f$, with persistence parameter ρ and a white-noise disturbance $\upsilon_j^f \sim N\left(0, \sigma_\upsilon^2\right)$.

Different from the male earning ability, the female earning ability $e_{j,\lambda}^f$ contains an endogenously evolving human capital component. In other words, $h_{j,\lambda}^f$ accumulates over life cycle according to a law of motion

$$log(h_{j,\lambda,\ell}^f) = log(h_{j-1,\lambda,\ell}^f) + \left(\xi_{1,\lambda,\ell} + \xi_{2,\lambda,\ell} \times (j-1)\right) \mathbf{1}_{\{\boldsymbol{\ell_{j-1}} \neq \mathbf{0}\}} - \delta_l(1 - \mathbf{1}_{\{\boldsymbol{\ell_{j-1}} \neq \mathbf{0}\}}), \tag{5}$$

where $\xi_{1,\lambda,\ell}$ and $\xi_{2,\lambda,\ell}$capture the human capital gain from working, i.e., $\ell \neq 0$, and δ_ℓ is the depreciation rate of human capital when not working, i.e., $\ell = 0$. The human capital gain parameters differ between full time and part time work and are calibrated such that the life cycle paths of human capital of married and single women match those of their male counterparts should they choose to work without time off.[11]

[10]The defining parameters of trade-offs that occur when a female labor supply decision is made are parameters associated with the costs and benefits of work for women, and not limited to the FTB and the CCS parameters. An example is the human capital accumulation rate which determines the maximum wage a woman may earn should she choose to work with no time off. High education women have a higher rate of human capital accumulation relative to that of their low education counterparts. High-skilled working women are thus less likely to respond to an increase in the FTB transfer. As a corollary, we also see less of their movement into the labor market when the FTB is eliminated since the majority of their members were already in the labor market to begin with.

[11]Human capital gain can take the form of experience gain, new skill acquisition and the like, and materializes in an increase in return to labor. In this sense, the law of motion employed is more akin to the learning-by-doing human capital accumulation as opposed to the on-the-job training framework, the latter of which requires an agent to actively

The costs of work. Entering the labor force is costly. If a woman works, she (i) *incurs a formal child care cost per child* κ_j, (ii) *loses a portion or all of the means-tested FTB transfers*, and (iii) *sacrifices leisure, and incurs a fixed time cost* (χ) *and per child time cost* (χ_{c,j_c}) *if she works full time.* With regards to (iii), we can say more precisely that at age j, her labor choice (ℓ), number (nc) and age (j_c) of dependent children affects her leisure time l_j^f in the following sense

$$l_j^f = \begin{cases} 1 & \text{if stay at home } (\ell = 0) \\ 0 < 1 - n_{j,\lambda,\ell=1}^f < 1 & \text{if work part time } (\ell = 1) \\ 0 < 1 - n_{j,\lambda,\ell=2}^f - (\chi + \chi_{c,j_c} \times nc_j) < 1 & \text{if work full time } (\ell = 2). \end{cases} \tag{6}$$

where $n_{j,\lambda,\ell}^f$ denotes the exogenous age-profile of average work hours for women. χ is the fixed leisure cost associated with full time work (with or without children). For a mother working full time, she incurs an additional cost, χ_{c,j_c}, per child that declines in a step-wise linear fashion as a child grows older. We use these parameters to produce a more realistic age-profile of female labor participation as well as full-time and part-time shares of female employment.

A woman's labor supply therefore hinges on the costs and benefits of work which are influenced by, *inter alia*, her time cost associated with work and children, the cost of formal child care service, her earning ability and shocks, her human capital potential, and the consumption insurance and work incentive effects of the family and child support schemes (FTB and CCS).

3.4 Technology

There is a representative firm with labor-augmenting technology A and a Cobb-Douglas production function that transforms capital K and labor services L into output Y. In every period t, this is given by $Y_t = K_t^\alpha (A_t L_t)^{1-\alpha}$ where A_t grows at a constant rate, g. Capital depreciates at the rate of δ. The firm pays capital income tax, and chooses capital and labor inputs to maximize its profit, taking as given the rental rate $q = r + \delta$ and the wage rate w according to

$$\max_{K_t, L_t} \quad (1 - \tau_t^k)(Y_t - w_t A_t L_t) - q_t K_t, \tag{7}$$

The firm's FOC yields:

$$r_t = (1 - \tau_t^k)\alpha \frac{Y_t}{K_t} - \delta, \tag{8}$$

$$w_t = (1 - \alpha) \frac{Y_t}{A_t L_t} \tag{9}$$

3.5 Fiscal policy

We model key features of the Australian fiscal system including the progressive income tax, means-tested transfer programs to families with children, i.e., the Family Tax Benefits (FTB) and the Child Care Subsidy (CCS) programs, and the means-tested Age Pension system for retirees..

invest in human capital augmenting factors by splitting her work time between productive time and training time. Part of the complication of this setup has to do with the issue of identifying return to productive time in the data since we do not actually observe it in reality.

Progressive income tax. The government levies tax on individual labor and capital earnings via a progressive income tax schedule.[12] The taxable income for an individual $i \in \{m, f\}$ at age j is $\widetilde{y}^i_{j,\lambda}$ which includes labor income $y^i_{j,\lambda}$, and capital income ra_j if single or a half of household capital income $\frac{ra_j}{2}$ if married. We can express $\widetilde{y}^i_{j,\lambda}$ as $\widetilde{y}^i_{j,\lambda} = y^i_{j,\lambda} + \mathbf{1}_{\{\lambda=0\}}\frac{ra_j}{2} + \mathbf{1}_{\{\lambda\neq 0\}}ra_j$. We summarize the tax schedule (with varying statutory marginal tax rates and income tax brackets) using a parametric tax function commonly employed in the literature. Suppressing the λ subscript and i superscript, the individual income tax payment is given by

$$tax^i_j = \max\left\{0, \widetilde{y}_j - \zeta \widetilde{y}_j^{1-\tau}\right\}, \tag{10}$$

where tax^i_j denotes the tax payment, ζ is a scaling factor, and τ is the parameter that controls the progressivity of the tax scheme. On one extreme end, if τ approaches infinity, tax^i_j approaches $\tilde{y}^i_j$ implying 100% of the taxable income is taxed. On the other extreme end, if $\tau = 0$, then $tax^i_j = (1-\zeta)\tilde{y}^i_j$ and thus $(1-\zeta)$ is a flat tax rate. We impose a non-negative tax restriction in the benchmark model, $tax^i_j \geq 0$. This restriction means all government transfers in the form of negative income tax are excluded. All government transfers are either explicitly modeled or included as exogenous spending in the general government purchase.

Family Tax Benefits. The government runs means-tested social security schemes in the form of direct transfers to help eligible parents with the cost of raising children. There are two such programs: Family Tax Benefit Part A (FTB A) and Family Tax Benefit Part B (FTB B). Below are simplified versions of the actual programs. For further details, we refer the interested readers to Appendix A.

Family Tax Benefit Part A (FTB A). The FTB A is paid per dependent child. The claimable amount depends on household combined taxable income, age and number of dependent children. The key policy parameters that determine the levels, kinks, and slopes of the FTB A schedule are: (i) maximum and base payments per child, i.e., tr^{A1}_j and tr^{A2}_j, (ii) income test thresholds for the maximum and base payments, i.e.,$\bar{y}^{tr}_{max}$ and $\bar{y}^{tr}_{base}$, and (iii) taper rates for the maximum and base payments, i.e., ω_{A1} and ω_{A2} . That is, the FTB A benefit per child, tr^A_j, received by a household is given by

$$tr^A_j = \begin{cases} tr^{\text{A1}}_j & \text{if } y_{j,\lambda} \leq \bar{y}^{tr}_{max} \\ \max\left\{tr^{\text{A2}}_j,\ tr^{\text{A1}}_j - \omega_{A1}\left(y_{j,\lambda} - \bar{y}^{tr}_{max}\right)\right\} & \text{if } \bar{y}^{tr}_{max} < y_{j,\lambda} < \bar{y}^{tr}_{base} \\ \max\left\{0,\ tr^{\text{A2}}_j - \omega_{A2}\left(y_{j,\lambda} - \bar{y}^{tr}_{base}\right)\right\} & \text{if } y_{j,\lambda} \geq \bar{y}^{tr}_{base}, \end{cases} \tag{11}$$

where $y_{j,\lambda} = \mathbf{1}_{\{\lambda\neq 2\}}y^m_{j,\lambda} + \mathbf{1}_{\{\lambda\neq 1,\ell>0\}}y^f_{j,\lambda} + ra_j$ denotes the household combined income.

Family Tax Benefit Part B (FTB B). The FTB B is paid per household to offer additional support to single parents and single-earner partnered parents with limited means. Similar to the FTB A, the FTB B is a function of age and number of dependent children. However, the eligibility and amount claimable are also determined by marital status and separate tests on primary earner's and secondary earner's individual taxable income. Important parameters that determine the levels, kinks and slopes of the FTB B benefit schedule are: (i) two maximum payments for families with children below age 5 or between age 5 and 18, i.e., tr^{B1}_j and tr^{B2}_j, (ii) separate income test thresholds on primary and secondary earners, i.e., $\bar{y}^{tr}_{pe}$ and $\bar{y}^{tr}_{se}$, and (iii) a taper rate based on the secondary earner's

[12] Australia runs a separate tax filing system which treat individual, and not household, as the basic unit for income tax purpose.

taxable income,i.e., ω_B. Let $y_{pe} = \max(y^m_{j,\lambda},\, y^f_{j,\lambda})$ and $y_{se} = \min(y^m_{j,\lambda},\, y^f_{j,\lambda})$ denote primary earner's and secondary earner's taxable income, respectively. The amount of FTB B received by a household, tr^B_j, is then given by

$$tr^B_j = \begin{cases} \Upsilon_1 \times tr^{\text{B1}}_j + \Upsilon_2 \times tr^{\text{B2}}_j & \text{if } y_{pe} \le \bar{y}^{tr}_{pe} \text{and } y_{se} \le \bar{y}^{tr}_{se} \\ \\ \Upsilon_1 \times \max\left\{0,\ tr^{\text{B1}}_j - \omega_B(y_{se} - \bar{y}^{tr}_{se})\right\} & \text{if } y_{pe} \le \bar{y}^{tr}_{pe} \text{and } y_{se} > \bar{y}^{tr}_{se} \\ +\Upsilon_2 \times \max\left\{0,\ tr^{\text{B2}}_j - \omega_B(y_{se} - \bar{y}^{tr}_{se})\right\} & \end{cases} \tag{12}$$

where $\Upsilon_1 = \mathbf{1}_{\{nc_{[0,4],j} \ge 1\}}$ and $\Upsilon_2 = \mathbf{1}_{\{nc_{[0,4],j}=0\, and\, (nc_{[5,15],j} \ge 1 \ or\ nc_{[16,18]_{AS},j} \ge 1)\}}$ are indicator variables, $nc_{[a,b],j}$ is the number of dependent children in the age range $[a,b]$ for households aged j, and $nc_{[a,b]_{AS},j}$ is the number of dependent children attending school in the age range $[a,b]$ for households aged j.

Child care subsidy. The government also runs a social welfare program in the form of indirect subsidy on formal child care costs for children aged 13 or younger. Like the FTB, the CCS is income means-tested (on joint family income, $y_{j,\lambda}$) and depends on the age and number of dependent children. In contrast, the CCS is conditional on work.[13] Key parameters determining eligibility and rate of subsidy per child include (i) income test thresholds; i.e., $\{\bar{y}^{sr}_1, \bar{y}^{sr}_2, \bar{y}^{sr}_3, \bar{y}^{sr}_4, \bar{y}^{sr}_5\}$, (ii) fortnightly work hour test thresholds; i.e., $\{0, 8, 16, 48\}$, and (iii) taper rates; i.e., $\{\omega^1_c, \omega^3_c\}$ determined by a taper unit (defined as the size of income increment by which the subsidy rate falls by 1 percentage point). We further assume

1. Perfectly competitive child care service; therefore, a uniform child care fee,
2. No annual cap on hourly fee and on subsidy per child,[14]
3. Households exhaust all available hours of subsidized care.

The child care subsidy per child, sr, at age j is

$$sr = \Psi(y_{j,\lambda}, n^m_{j,\lambda}, n^f_{j,\lambda,\ell}) \times \begin{cases} sr_1 & \text{if } y_{j,\lambda} \le \bar{y}^{sr}_1 \\ max\{sr_2,\ sr_1 - \omega^1_c\} & \text{if } \bar{y}^{sr}_1 < y_{j,\lambda} < \bar{y}^{sr}_2 \\ sr_2 & \text{if } \bar{y}^{sr}_2 \le y_{j,\lambda} < \bar{y}^{sr}_3 \\ max\{sr_3,\ sr_2 - \omega^3_c\} & \text{if } \bar{y}^{sr}_3 \le y_{j,\lambda} < \bar{y}^{sr}_4 \\ sr_3 & \text{if } \bar{y}^{sr}_4 \le y_{j,\lambda} < \bar{y}^{sr}_5 \\ sr_4 & \text{if } y_{j,\lambda} \ge \bar{y}^{sr}_5 \end{cases} \tag{13}$$

Where the joint income is $y_{j,\lambda} = \mathbf{1}_{\{\lambda \ne 2\}} y^m_{j,\lambda} + \mathbf{1}_{\{\lambda \ne 1, \ell > 0\}} y^f_{j,\lambda} + ra_j$ and the taper rate can be calculated as $\omega^i_c = \dfrac{y_{j,\lambda} - \bar{y}^{sr}_i}{taper\ unit}$. In 2018, the taper unit = AU\$3,000.

[13] Work is a more restrictive term used for our purpose. In practice, the CCS tests hours of recognized activities which comprise, among others, paid work (including self-employed), unpaid work in a family business, paid or unpaid leave, volunteering, and job seeking activities.

[14] The removal of caps on hourly fee and subsidy in the model is innocuous since households only make participation and not work hour decision. The exogenous work hours based on the observed age-profiles of average part-time and full-time work hours by gender and marital status are below the CCS hour cap. The uniform child care fee assumption also eliminates the need to impose hourly child care fee cap. These caps are therefore non-binding.

$\Psi(y_{j,\lambda}, n^m_{j,\lambda}, n^f_{j,\lambda,\ell})$ is the adjustment factor to the statutory subsidy rate through a work hour test on individual work hours if single or on the lower of the two spouses' hours if married. Let $n^{min}_j = min\{n^m_{j,\lambda}, n^f_{j,\lambda,\ell}\}$. The adjustment factor is

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

Otherwise, $\Psi(y_{j,\lambda}, n^m_{j,\lambda}, n^f_{j,\lambda,\ell}) = 0$.

Means-tested Age Pension. The Age Pension program is funded by the general government budget and is available to households upon having reached the age threshold $j = J_P$. Pension is not universal and targets low income households through the use of income and assets tests. Let $y_{j,\lambda} = \mathbf{1}_{\{\lambda \neq 2\}} y^m_{j,\lambda} + \mathbf{1}_{\{\lambda \neq 1, \ell > 0\}} y^f_{j,\lambda} + r a_j$ denote household income and a_j denote the total assets at age j that are subject to income and assets tests, respectively. The amount of pension benefit, pen_j, received by a household is given by

$$pen_j = \begin{cases} \min\left\{\mathcal{P}^a\left(a_j\right), \mathcal{P}^y\left(y_{j,\lambda}\right)\right\} & \text{if } j \geq J_P \text{ and } \lambda = 0 \\ \dfrac{2}{3}\min\left\{\mathcal{P}^a\left(a_j\right), \mathcal{P}^y\left(y_{j,\lambda}\right)\right\} & \text{if } j \geq J_P \text{ and } \lambda = 1, 2 \\ 0 & \text{otherwise} \end{cases} \tag{14}$$

$\mathcal{P}^a(a_j)$ is the claimable pension benefit based on the assets test

$$\mathcal{P}^a\left(a_j\right) = \begin{cases} p^{\max} & \text{if } a_j \leq \bar{a}^P_1 \\ \max\left\{0,\ p^{\max} - \omega_a\left(a_j - \bar{a}_1\right)\right\} & \text{if } a_j > \bar{a}^P_1, \end{cases} \tag{15}$$

where $\bar{a}^P_1$ is the assets test threshold and ω_a is its corresponding taper rate.

$\mathcal{P}^y\left(y_{j,\lambda}\right)$, on the other hand, is the claimable amount according to the income test on household income

$$\mathcal{P}^y\left(y_{j,\lambda}\right) = \begin{cases} p^{\max} & \text{if } y_{j,\lambda} \leq \bar{y}^p_1 \\ \max\left\{0,\ p^{\max} - \omega_y\left(y_{j,\lambda} - \bar{y}^p_1\right)\right\} & \text{if } y_{j,\lambda} > \bar{y}^p_1, \end{cases} \tag{16}$$

where $\bar{y}^p_1$ is the income test threshold and ω_y is the income taper rate.

Government budget. The government at time t collects taxes on consumption, company profit and household income (T^C_t, T^K_t, T^I_t), and issues bond $(B_{t+1} - B_t)$ to meet its debt obligation $(r_t B_t)$ and its commitment to three spending programs: (i) the general government purchase, G_t; (ii) the family and child support programs (FTB + CCS), Tr_t; and the age pension, $\mathcal{P}_t$.[15] The intertemporal fiscal budget balance equation is

$$T^C_t + T^K_t + T^I_t + \left(B_{t+1} - B_t\right) \quad = \quad G_t + Tr_t + \mathcal{P}_t + r_t B_t \tag{17}$$

[15]Throughout analyses, we assume G_t and B_t are kept at constant fractions of the initial steady state GDP (Y_0), i.e., $G_t = frac_G \times Y_0,\ and\ \ B_t = frac_B \times Y_0$.

3.6 Market structure

Markets are incomplete and households cannot insure against idiosyncratic labor income and mortality risks by trading state contingent assets. They can hold one-period risk-free assets to imperfectly self-insure against these risks. We assume agents are not allowed to borrow against future income such that $a_j \geq 0$ for all j, implying asset holdings are non-negative.[16]

The model economy is a small open economy in which the rate of return to capital, and thus labor, are unchanged across steady states. The free flow of foreign financial capital ensures that the domestic interest rate is maintained at a constant world interest rate, r^w. The link between the rental price of capital and the world interest rate is given by $q = r^w + \delta$.

We also abstract from labor market frictions. There are no search for employment, and no adjustment cost when switching between part-time and full-time work.

3.7 The household problem

Households are heterogeneous in terms of age $j \in \{1, 2, \ldots, J\}$, household type $\lambda \in \{0, 1, 2\}$,education/permanent skill level $\theta \in \Theta$ where $\Theta = \{\theta_l, \theta_h\}$ realized at birth $j = 1$, human capital level of the wife $h^f_{j,\lambda} \in [h_{min}, h_{max}]$, asset holdings $a_j \in [a_{min}, a_{max}]$ and transitory shocks to male and female labor income,$\epsilon^m_j$and ϵ^f_j.

Working households. Define $Z = \Lambda \times A \times H \times \Theta \times S \times S = \{0, 1, 2\} \times R_+ \times R_+ \times \{\theta_l, \theta_h\} \times \{1, 2, 3, 4, 5\} \times \{1, 2, 3, 4, 5\}$ as the state space for each household aged $j < J_R$.[17] Let $z_j = \left\{\lambda_j, a_j, h^f_{j,\lambda,\ell}, \theta, \eta^m_j, \eta^f_j\right\} \in Z$ be a composite state variable and $V(z_j)$ be the value function for a household aged j with state z_j. For a given state combination realized at the beginning of a period, the household decides on joint consumption (c_j), female labor supply (ℓ_j), and next period joint assets (a_{j+1}) from a choice set $\mathcal{C}_j \equiv \{(c_j, \ell_j, a_{j+1}) \in R_{++} \times \{0, 1, 2\} \times R_+\}$ to maximize its expected lifetime utility according to

$$V(z_j) = \max_{c_j, \ell_j, a_{j+1}} \left\{ u(c_j, l^m_j, l^f_j, \lambda_j, nc_j) + \beta \sum_{\Lambda} \int_{S^2} V(z_{j+1})\, d\Pi(\lambda_{j+1}, \eta^m_{j+1}, \eta^f_{j+1} | \lambda_j, \eta^m_j, \eta^f_j) \right\} \quad (18)$$

$s.t.$

$$(1 + \tau^c)c_j + (a_{j+1} - a_j) + \mathbf{1}_{\{\lambda \neq 1,\, \ell_j > 0\}} fcc_j = y_{j,\lambda} + \mathbf{1}_{\{\lambda \neq 1\}}(nc_j \times tr^A_j + tr^B_j) + beq_j - tax_j \quad (19)$$

$$c_j > 0 \quad (20)$$

$$a_{j+1} \geq 0 \quad (21)$$

$$l^m_j = 1 - n^m_{j,\lambda} \quad \text{if} \quad \lambda = 0 \text{ or } \lambda = 1 \quad (22)$$

$$l^f_j = 1 - \mathbf{1}_{\{\ell > 0\}} n^f_{j,\lambda,\ell} - \mathbf{1}_{\{\ell = 1\}}(\chi + \chi_{c,j_c} \times nc_j) \quad \text{if} \quad \lambda = 0 \text{ or } \lambda = 2 \quad (23)$$

where β is the time discount factor; $y_{j,\lambda} = (\mathbf{1}_{\{\lambda \neq 2\}} y^m_{j,\lambda} + \mathbf{1}_{\{\lambda \neq 1,\, \ell_j > 0\}} y^f_{j,\lambda} + r a_j)$ is the total household

[16] Without a borrowing constraint, it would require a higher relative risk aversion parameter (lower elasticity of intertemporal substitution) to generate a time path of consumption that is not too erratic. In the presence of borrowing constraint, however, we can set the relative risk aversion parameter lower than observed in practice. One reason is that the constraint serves to prevent young economic agents from borrowing against their future income, and hence, allows a realistic consumption path in a model environment with low relative risk aversion value.

[17] For computational purpose, the transitory shock space is discretized into a Markov process with 5 shock values and a 5×5 transition probability matrix using the Rouwenhorst method.

market income; $fcc_j = wn^f_{j,\lambda}\sum_{i=1}^{nc_j}(1-sr_{j,i})\kappa_{j,i}$ is the total formal child care cost net of the CCS subsidized amount, tr^A_j and tr^B_j are the FTB part A and B transfers; $\kappa_{j,i}$ and $sr_{j,i}$ in the fcc equation are the child care cost and CCS subsidy rate for the i^{th} child for household aged j, respectively; τ^c is the consumption tax; and $tax_j = (\mathbf{1}_{\{\lambda\neq 2\}}tax^m_j + \mathbf{1}_{\{\lambda\neq 1\}}tax^f_j)$ is the joint income tax payment. Bequest motive is not operative. Each alive working-age household at age j receives a uniform lump-sum transfer of accidental bequest, beq_j, from deceased households in the same period.[18]

Retired households. When households become eligible for the Age Pension starting from age J_P, they withdraw from the labor force. The permanent (education) and transitory shock states becomes absorptive states. In addition, since children are no longer dependent by the time parents have reached the pension age, retirees are not eligible for any child-related transfers. Pension payout is not conditional on earnings history but is conditional on household type, λ. An eligible single household receives only two-third of the maximum pension benefit that a couple would receive. The state vector of a retired household is therefore simplified to $z^R_j = \{\lambda_j, a_j\} \in \{0,1,2\}\times R_+$. The retired household optimization problem reduces to

$$
\begin{aligned}
V(z^R_j) &= \max_{c_j,\,a_{j+1}} \left\{ u(c_j,\lambda_j) + \beta \sum_{\Lambda} V(z^R_{j+1})\, d\Pi(\lambda_{j+1}|\lambda_j) \right\} \qquad (24)\\
s.t.&
\end{aligned}
$$

$$
\begin{aligned}
(1+\tau^c)c_j + (a_{j+1}-a_j) &= ra_j + pen_j - tax_j\\
c_j &> 0\\
a_{j+1}\geq 0 \quad and &\quad a_{J+1} = 0
\end{aligned}
$$

where pen_j is the total age pension described in equation 14.

3.8 Competitive equilibrium

The distribution of households. Let $\phi_t(z_j)$ and $\Phi_t(z_j)$ denote the population growth- and mortality-unadjusted stationary density and cumulative distribution of households aged j in time t, respectively.[19] Given that households enter the economy with zero human capital ($h_{j=1}=0$) and assets ($a_{j=1}=0$), the initial distribution of newborns ($j=1$) in every period t is determined by

$$
\begin{aligned}
\int_{\Lambda\times A\times H\times\Theta\times S^2} d\Phi_t(\lambda,a,h,\theta,\eta^m,\eta^f) &= \int_{\Lambda\times\Theta\times S^2} d\Phi_t(\lambda,0,0,\theta,\eta^m,\eta^f) = 1, \quad \text{and}\\
\phi_t(\lambda,0,0,\theta,\eta^m,\eta^f) &= \prod_{x\in\{\lambda,\theta,\eta^m,\eta^f\}} \pi(x)
\end{aligned}
$$

We suppress subscripts of the state variables for brevity. $\pi(x)$ is the unconditional probability density of state $x \in \{\lambda,\theta,\eta^m,\eta^f\}$ for all $\lambda\in\{0,1,2\},\ \theta\in\Theta,$ and $\eta^m,\eta^f\in S$.

[18] Provided that the age-profiles of work hours are exogenous, $0<l^i_j<1$ for all $i\in\{m,f\}$ by construction.

[19] Because population growth rate is a constant, and mortality is age-dependent but independent of the other state elements, adjustment for population growth and mortality can be done later when aggregating over cohorts.

From age $j = 2$ onward, the population density $\phi_t(z)$ evolves according to the following law of motion

$$\phi_{t+1}(z^+) = \int_{\Lambda\times A\times H\times\Theta\times S^2} \mathbf{1}_{\{a^+=a^+(z,\Omega_t),\, h^+=h^+(z,\Omega_t)\}} \times \pi(\lambda^+|\lambda) \times \pi(\eta^m_+|\eta^m) \times \pi(\eta^f_+|\eta^f)\, d\Phi_t(z) \quad (25)$$

where Ω_t is a vector of parameters at time t, $\pi(\eta^i_+|\eta_+)$ is the probability of η^i_+ conditional on η^i for $i \in \{m, f\}$, and $\pi(\lambda^+|\lambda)$ is the transition probability of λ^+ given λ taken from Table 4. In practice, assets and human capital are discretized. These endogenous states however evolve continuously, and for this reason, the share of households on each pair of the next period a^+ and h^+ grid points are obtained through linear interpolations of $a^+$and $\log(h^+)$ on the current period assets (A) and human capital domains (H), respectively.

Aggregate variables. There are J number of generations living in every period t. Let the share of alive cohort j at time t be denoted by $\mu_{j,t}$ such that $\sum_{j=1}^{J} \mu_{j,t} = 1$. Taking into account the optimal decisions $\{c(z,\Omega_t),\, \ell(z,\Omega_t),\, a(z,\Omega_t)\}_{j=1}^{J}$ and the unit mass of households, aggregate variables for the model economy are equivalent to per capita variables. Hence, the per capital terms of consumption C_t, private wealth A_t, female labor force participation rate LFP_t, and labor supply in efficiency unit for male LM_t and female LF_t in every period t are expressed as

$$C_t = \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} c(z_j,\Omega_t)\mu_{j,t}\, d\Phi_t(z_j) \quad (26)$$

$$A_t = \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} a(z_j,\Omega_t)\mu_{j,t}\, d\Phi_t(z_j) \quad (27)$$

$$LFP_t = \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} \mathbf{1}_{\{\ell(z_j,\Omega_t)\neq 0\}}\mu_{j,t}\, d\Phi_t(z_j). \quad (28)$$

$$LM_t = \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} h^m_{j,\lambda} e^{\theta+\eta^m} n^m_{j,\lambda}\mu_{j,t}\, d\Phi_t(z_j) \quad (29)$$

$$LF_t = \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} \mathbf{1}_{\{\ell(z_j,\Omega_t)\neq 0\}} h^f_{j,\lambda,\ell} e^{\theta+\eta^f} n^f_{j,\lambda,\ell}\mu_{j,t}\, d\Phi_t(z_j). \quad (30)$$

The aggregate government variables are

$$T^C_t = \tau^c_t C_t \quad (31)$$

$$T^K_t = \tau^k_t (Y_t - w_t A_t L^s_t) \quad (32)$$

$$T^I_t = \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} tax_j \mu_{j,t}\, d\Phi_t(z_j). \quad (33)$$

$$Tr_t = \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} (ftba_j + ftbb_j + ccs_j)\, \mu_{j,t}\, d\Phi_t(z_j) \quad (34)$$

$$\mathcal{P}_t = \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} pen_j \mu_{j,t}\, d\Phi_t(z_j). \quad (35)$$

where $ftba_j, ftbb_j$ and ccs_j are the total FTB A, FTB B and CCS benefit amount for cohort j, and the total labor supply $L_t^s = LM_t + LF_t$.

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

(a) The collection of individual household decisions $\{c_j, \ell_j, a_{j+1}\}_{j=1}^J$ solves the household problem 18 and 24;

(b) The firm chooses labor and capital inputs to solve its profit maximization problem 7;

(c) The government budget constraint 17 is satisfied;

(d) The factor markets clear, $K_t^s = K_t^d = K_t$ and $L_t^s = L_t^d = L_t$, where

$$K_t^s = A_t + B_t + B_{F,t} \quad (36)$$

$$L_t^s = LM_t + LF_t; \quad (37)$$

(e) The goods market clears:

$$\begin{aligned} Y_t &= C_t + I_t + G_t + NX_t \quad (38) \\ NX_t &= (1+n)(1+g)B_{F,t+1} - (1+r)B_{F,t} \\ B_{F,t} &= A_t - K_t - B_t \end{aligned}$$

where $I_t = (1+n)(1+g)K_{t+1} - (1-\delta)K_t$ is investment.[20]

(f) The lump-sum bequest is the total untapped end-of-period private wealth left by deceased agents in time t. Given the known survival probabilities, the total amount of bequest available at any time t can be accurately predicted. That is,

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

$\psi_{j,\lambda}$ is the conditional survival probability for each household type λ at age j.[21] Bequest to each surviving household aged j at time t is determined by a general formula

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

where $b_{j,t}$ is the share of bequest for each surviving household aged j at time t, and $m_{j,t}$ is the mass of households.[22] We assume bequest is uniformly distributed to each alive working-age household.

[20] See subsection B for detailed explanation on $B_{F,t}$ and NX_t.

[21] For married households ($\lambda = 0$), $\psi_{j,0} = 1 - (1-\psi_j^m)(1-\psi_j^f)$ is the probability that both spouses survive.

[22] There are alternative methods one can choose to handle leftover wealth of the deceased. One way is to introduce annuity market. Households fully annuitize their savings by entering into a contract with financial intermediaries. There

Then, we can write $b_{j,t} = \frac{1}{JR-1}$ if $j < JR$ and $b_{j,t} = 0$ otherwise. The amount of bequest to a household aged j at time t is therefore

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

4 Calibration

We model our economy on a balanced growth path where consumption, investment and capital grow at a constant growth rate g of labor-augmented technology while the time endowment for labor and leisure is fixed. The classes of parametric functions for preference and technology are chosen to reflect the observed macroeconomic facts and for comparability with the past research on related issues.

We calibrate the model to match key statistics of the 2012-2018 Australian economy. Externally calibrated parameters are summarized in Table 5. They are obtained either from our estimates using the HILDA survey, estimates widely used in similar studies on Australia, or those from publicly available data provided by Australian governmental bodies - e.g., the Australian Bureau of Statistics (ABS) and the Department of Social Services (DSS) - or from international organizations, namely, the World Bank. The remaining micro and macro parameters are calibrated internally to match key model moments to a set of target moments from the data. These parameters and their targets are in Table 5. In addition, we test our model performance by comparing a set of non-targeted data moments with their model counterparts. We find that our benchmark model does reasonably well in matching the selected empirical facts of the Australian economy. Results are shown in Table 7

4.1 Demographics

Since the main objective is to capture household behavioral responses to transfer programs concentrated within the child-bearing and raising age, a model that offers a high-resolution picture of the life-cycle of economic agents is desirable. In light of this consideration, we set one model period to correspond to one year of life. In every period t, a unit mass of households is born. They enter the model economy at age 21 ($j = 1$) as workers, retire at age 65 ($j = J_R$ =45), and live to the maximum age of 100 ($j = J = 80$).[23] $\psi_{j,m}$ and $\psi_{j,f}$ are time-invariant average conditional survival probabilities for males and females from the 2001-2019 ABS Life Tables. The growth rate of newborn agents is kept constant at $n = 1.6\%$ which is the average annual population growth rate in Australia between 2012-2018. The share of newborn households by marital type, $\pi(\lambda)$, is estimated from the HILDA survey. Based on these estimates, married households comprise 70% of the newborns ($\pi(\lambda = 0) = 0.70$). The remaining 30% are single households, 53% of which are female, such that $\pi(\lambda = 1) = 0.14$ and $\pi(\lambda = 2) = 0.16$.[24]

are also implementations such as introducing a parent-child link in the objective function of a household. However, this is computationally expensive as it requires an additional continuous state element to store the wealth of parents (necessary to determine the optimal savings paths for the children). This expansion of the state space with the already high dimensionality of our problem is not desirable. Nonetheless, as will be shown later, bequest tends to be small and inconsequential to the outcome of our study, especially provided that our focus is on transfer policies to the low income and target demographics.

[23]We set productivity to zero from age J_R onward so that retirement is mandatory.

[24]The Australian Institute of Family Studies shows similar figures in their 2018 facts and figures report. Note that, these estimated household shares by marital status are for age 21 to 65.

Parameter	Value	Target
Demographics		
Maximum lifespan	$J = 80$	Age 21-100
Mandatory retirement age	$J_R = 45$	Retirement age 65
Population growth rate	$n = 1.6\%$	Average (ABS 2012-2018)
Survival probabilities	ψ_m, ψ_f	Australian Life Tables (ABS 2010-2019)
Measure of newborns by λ type	$\{\pi(\lambda_0),\ \pi(\lambda_1),\ \pi(\lambda_2)\} = \{0.70,\ 0.14,\ 0.16\}$	HILDA 2010-2018
Technology		
Labor augmenting technology growth	$g = 1.3\%$	Average per hour worked growth rate (World Bank 2012-2018)
Output share of capital	$\alpha = 0.4$	Output share of capital for Australia
Real interest rate	$r = 4\%$	Average (World Bank 2012-2019)
Households		
Relative risk aversion	$\sigma = 1/\gamma = 3$	Standard values 2.5-3.5
Male and female labor supply	$n_{m,\lambda},\ n_{f,\lambda}$	Age-profiles of average labor hours (HILDA)
Male human capital profile	h^m_λ	Age-profile of wages for married men (HILDA)*
Permanent shocks at birth (education)		
Permanent shock value	$\{\theta_L, \theta_H\} = \{0.745, 1.342\}$	College-High school wage ratio of 1.8**
Measure of households by θ type	$\{\pi(\theta_L),\ \pi(\theta_H)\} = \{0.7,\ 0.3\}$	College to high school ratio (ABS 2018)
Fiscal policy		
Progressive income tax	$\zeta = 0.7237,\ \tau = 0.2$	Tran and Zakariyya (2021)***
Consumption tax	$\tau^c = 8\%$	$\tau_c \times \frac{C_0}{Y_0} = 4.5\%$; given $\frac{C_0}{Y_0} = 56.3\%$
Company profit tax	$\tau^k = 10.625\%$	$\tau^k \left(\frac{Y - WL}{Y}\right) = 4.5\%$; where $\frac{WL}{Y} = 1 - \alpha$
Government debt to GDP	$\frac{B}{Y} = 20\%$	Average (CEIC 2012-2018)
Government 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
Others		
Model income unit	1 model unit $= \$24.02/hour \times 24 \times 5 \times 52$	Average male hourly wage at age 21 (HILDA)*

Table 5: Externally calibrated parameters

Notes: (*) Age-profile of hourly wages for married men is obtained by regressing $log(wage)$ on quadratic age terms and four dummies (gender, marital status, employment type and time). We then normalize all hourly wage estimates by the average hourly wage of male aged 21. Given that all resources are generated internally in the model, a model income unit is equivalent to $\$24.02/hour \times 24 \times 5 \times 52$ real world AUD. (**) A rough estimate based on Grattan Institute study using the ABS 2016 Census. See https://theconversation.com/three-things-high-school-graduates-should-keep-in-mind-when-they-have-their-atars-107601. Our own estimates using HILDA suggests a wage premium (college vs high school) for married men in the range of 1.7-1.8 over the 18 years period 2001-2018. (***) For computational reason, the current version of our model uses a proportional income tax system ($\tau = 0$) to calculate the budget balancing income tax rate.

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%
Fixed time cost of full-time work for women	$\chi = 0.14$	Mothers' full time rate 26-28% (40% of total female LFP)
Per child time cost of full-time work	$\{\chi_{c,j_c=[0,5]},\, \chi_{c,j_c=[6,11]}\} = \{0.0325,\, 0.005\}$	Full time share age-profile for mothers
Female human capital		
Depreciation rate	$\delta_h = 0.074$	Male-female wage gap at age 50
Accumulation rate for:		
Married mother working full-time	$(\xi_{1,\lambda=0,\ell=1}, \xi_{2,\lambda=0,\ell=1}) = (0.0450, -0.00175)$	Married father's age-profile of full-time wages
Married mother working part-time	$(\xi_{1,\lambda=0,\ell=2}, \xi_{2,\lambda=0,\ell=2}) = (0.0350, -0.00135)$	Married father's age-profile of part-time wages
Single mother working full-time	$(\xi_{1,\lambda=2,\ell=1}, \xi_{2,\lambda=2,\ell=1}) = (0.0206, -0.00088)$	Single father's age-profile of full-time wages
Single mother working part-time	$(\xi_{1,\lambda=2,\ell=2}, \xi_{2,\lambda=2,\ell=2}) = (0.0179, -0.00060)$	Single father's age-profile of part-time wages**
Technology		
Capital depreciation rate	$\delta = 0.07172$	$\frac{K}{Y} = 3.2$ (ABS, 2012-2018)
Transitory shocks		
Persistence parameter	$\rho = 0.98$	Literature
Variance of shocks	$\sigma_v^2 = 0.0145$	Gini coefficient of male wages at age 21, $GINI_{j=1,m} = 0.35$
Fiscal policy		
Maximum pension	$pen^{max} = 30\% \times Y$	Pension share of GDP, $\frac{\mathcal{P}_t}{Y_t} = 3.2\%$ (ABS, 2012-2018)

Table 6: Internally calibrated parameters

Notes: (*) We chose age 50 to allow sufficient time for δ_h to take effect on female labor supply decision. (**) We calibrate the female human capital accumulation and depreciation rates for a type $\{\lambda, \ell\}$ woman such that her age-profile of wages match that of her male counterpart if she chooses to work without time off. The target male moment values (i.e., male age-profiles of wages) are estimated for each pair $\{\lambda, \ell\}$ using the HILDA survey data. Some additional adjustments (e.g., by discarding wage data near retirement age) are made to better fit the estimated male profiles since data for some groups, such as single father, is noisy.

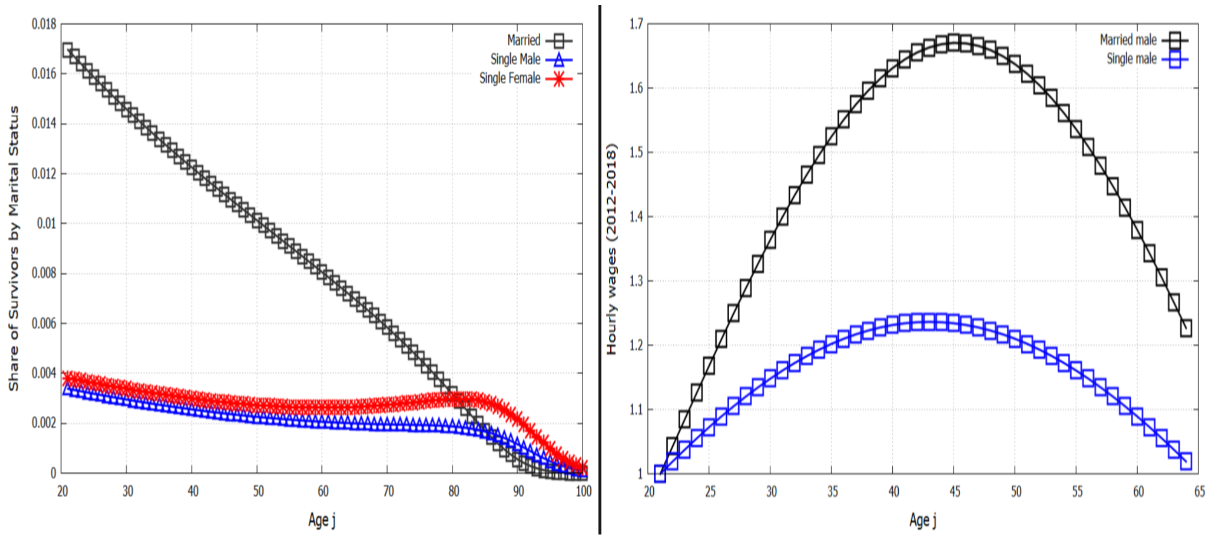

Figure 9: **Marital status and hourly wages over the life cycle. Left panel:** Shares of survivors by marital status over the life cycle. **Right panel:** Age profiles of hourly wages for married and single males.

4.2 Preferences

We calibrate the subjective discount factor $\beta = 0.99$ so that the household savings ratio stays between 5%-8% as reported by ABS statistics on the Australian National Accounts, and set the elasticity of intertemporal substitution (an inverse of relative risk aversion) to $\gamma = 1/3$ within the range of standard values commonly used in the literature. The taste for consumption relative to leisure, ν, is calibrated to 0.365 for the female labor force participation rate to stay within the range of 65-70%. The fixed time cost of full-time work, χ, is calibrated to 0.14 so that the model generated female full-time rate lies between 26-28% (40% of the female labor force). The per child additional leisure cost associated with full-time work, χ_{c,j_c}, is 0.0325 for a woman with a child aged 0-5 years old, 0.005 if her child's age is 6-11 years old, and zero otherwise. These extra costs are added to match the age-profile of full-time employment share for mothers.

4.3 Endowments

Deterministic productivity. We use the HILDA survey data (2001-2018) in estimating the age-profiles of hourly wages of single and married males. The values are then normalized by the average hourly wage of 21-year-old married fathers and are used as proxies for the male human capital profiles, h^m_λ.

Households are divided into two education/permanent skill types - low (θ_L) and high (θ_H) - realized at birth, representing those who have at most high school degree and those with bachelor's degree or higher qualifications, respectively. The earnings ability profile of an agent is scaled up or down by θ. We set $\theta_L = 0.745$ and $\theta_H = 1.342$ to achieve a college wage premium of 1.8 in the benchmark economy. The measures of low and high skilled households are $\pi(\theta_L) = 0.7$ and $\pi(\theta_H) = 0.3$ based on the college-high school ratio in the 2018 ABS data. .

We abstract from men's labor supply decision and women's intensive margin of labor supply decision, and externally estimate their age-profiles of normalized average work hours ($n^m_\lambda$and $n^f_{\lambda,\ell}$) by gender and marital status. Men always work full-time and follow the pre-determined labor supply paths. Women, single and married, can adjust their labor supply along the extensive margin in pursuit of the lifetime utility maximization objective. Specifically, a model household decides whether its adult female member ought to stay at home ($\ell = 0$), work part time ($\ell = 1$), or work full time ($\ell = 2$).[25] Their decision to work results in human capital gains, $\xi_{1,\lambda,\ell}$, whose magnitude declines over age at the rate of $\xi_{2,\lambda,\ell}$. We calibrate the human capital accumulation rates, $\{\xi_{1,\lambda,\ell}, \xi_{2,\lambda,\ell}\}$, by household type ($\lambda$) and labor choice ($\ell$) such that the life-cycle paths of human capital of single and married females mimic those of their respective male counterparts should they choose work without time off over their working age. A caveat is that this hinges on the assumption of ex-ante assortative matching; i.e., that married women possess the same human capital potential (pre-marriage) as their partners do. As evident in education and marriage statistics from HILDA, there was a fair amount of matching of unlike (between couples of different education levels) in the early 2000s. In recent time, however, our statistics suggest that marriage is predominantly between partners of similar education backgrounds.

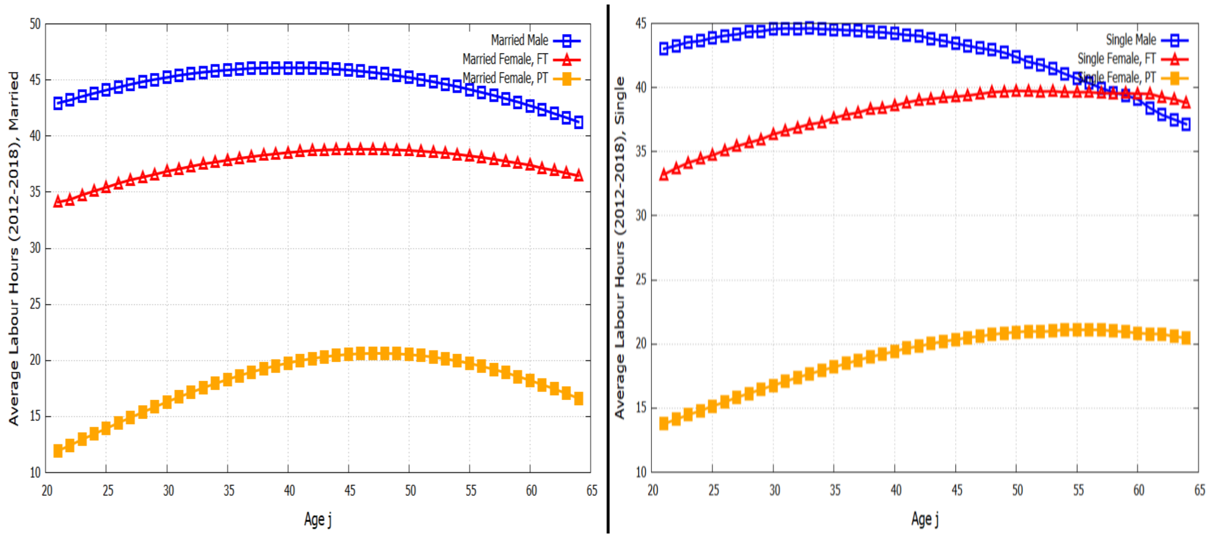

Figure 10: **Labor supply over the life-cycle. Left panel:** Age profiles of average labor hours for married parents. **Right panel:** Age profiles of average labor hours for single men and single mothers.
Note the difference between the two y-axes. The former ranges from 10 to 50 hours and the latter from 10 to 45 hours.

Stochastic productivity. Every adult household member is subject to idiosyncratic transitory earnings shocks η^i for $i \in \{m, f\}$. Their shocks follow identical AR1 processes with auto-correlation coefficient, ρ, and variance of the innovation, σ_v^2. We set $\rho = 0.98$ and calibrate σ_v^2 to match a Gini index of 0.35 for the wage distribution of married men aged 21. This configuration results in a wage Gini coefficient of 0.3766 (non-target) for the working age male population. The Rouwenhorst method is employed to discretize the shock values into 5 grid points $\{0.29813, 0.546011, 1.83146, 3.35424\}$ with the following Markov transition probabilities[26]

[25] Our estimates from HILDA demonstrate that male labor supply profiles remain virtually unchanged across selected demographics such as parental and marital status. We also conduct several empirical exercises by running logistic regressions of participation on lagged FTB benefits and demographic controls, which indicate that the work disincentive effect is trivial for men. On a similar note, Doiron and Kalb (2004) finds that the effects of child care cost increase on male labor supply is negligible. Evidence thus far suggests highly inelastic male labor supply. Hence, for our abstract environment that puts spotlight on women, this assumption is likely not a huge trade-off. In terms of female labor supply, one may argue that allowing work hour decision better captures the family insurance by married women in response to male earnings shocks. Tin and Tran Forthcoming 2023 show that spousal labor supply response to primary earner's earnings shocks is weak, though it could be linked to the presence of large government insurance in Australia.

[26] The difference between Rouwenhorst and Tauchen methods of discretization is that the former does not require

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

Children. Children are deterministic and exogenous. Provided that the majority of parents (40%) in our sample data have two children and to reduce the computational burden, our model households are assumed to have only two children over their lifetime.[27] The heterogeneity pertaining to children is attached to the skill type θ in the form of arrival time of a child. The longitudinal study of Australian children (LSAC) annual statistics report in 2017 shows that the largest share of first-time mothers within the 15-19 age range concentrates within the low education group (67.7%), and only around 10% of the 25-37year-old first-time mothers are of low education. On the contrary, close to half of the first-time mothers in the latter group have achieved a bachelor's degree or higher. We reflect this fact in the model by assigning the first child birth to type θ_L households aged 21 (i.e., $j = 1$, the youngest in the model economy) and type θ_H households aged 28. Then, for both low and high skilled households, the second child arrives exactly 3 years after the fist born, at age 24 and 31, respectively.[28] For tractability and based on the observation that women constitute the majority (87.21%) of lone parents in our sample, we assume only single and married female households in the model have children.

Child care cost. We abstract from informal child care and restrict the formal care service to have identical quality and price (a perfectly competitive market environment). With a conservative estimate of $12.5 per hour, the cost of child care is 52% of a 21-year-old married man's average hourly wages in the model. The total cost of formal child care for a household aged j is the sum of costs for all dependent children. Based on approximates from widely scattered data on fees of early child care service, primary, secondary and high schools in Australia, we assume child care cost declines as children age. That is, parents pay the full total cost of formal child care for a child aged 0-2 years old, 80% of the cost for age 3-5, 60% for age 6-11, and 40% for age 12-17.[29]

4.4 Technology

The production function is given by $Y = K^{\alpha}(AL)^{1-\alpha}$ where the capital output share is $\alpha = 0.4$. The labor augmenting technology A is set to 1 in the benchmark economy. Since the average annual GDP per hour worked growth rate in Australia is 1.3%, we set $g = 0.013$. Given α, the company profit tax rate $\tau^k = 10.625\%$, and the target capital-to-GDP ratio $K/Y = 3.2$, we use the firm's first-order conditions 8 to derive the capital depreciation rate $\delta = 0.07172$ in the initial steady state equilibrium.

normality assumption of the shock distribution. Rouwenhorst matches exactly, by construction, the first and second conditional moments and, by the law of iterated expectations, also the unconditional moments of the continuous process, independently of the shock distribution. Nonetheless, this still presents a limitation since we are not capturing the higher-order moments of shocks (e.g., third- and fourth-order moments) which tell a better story of the magnitude and probability of extreme shocks at the tailends of the earnings shock distribution.

[27] This holds true when we restrict the sample to older households (aged 50 and above) so that the resultant figure reflects the number of children the households have over life-cycle. In this case, we have 12% of households with 1 child, 41.68% with two, 28.38% with three, and the rest with four or above.

[28] The Australian Institute of Health and Welfare (AIHW) report shows that although the average age of mothers of first and second borns have risen from 27.9 and 31 years old, respectively, in 2009 to 29.4 and 31.9 years old in 2019, child spacing remains at around 3 years.

[29] A simple step-wise linear cost function marks a good starting point. In subsequent extensions, the child care service cost will be more precisely estimated.

4.5 Fiscal policy

Income tax. This paper employs a parametric income tax function 10 commonly used in the public finance literature (e.g., Heathcote, Storesletten and Violante (2017)). Our parameters of choice for the tax function, $\zeta = 0.7237$ and $\tau = 0.2$, follow an earlier study on tax progressivity in Australia by Tran and Zakariyya (2021).[30] Because $(1 - \zeta)$ is just a flat tax rate when $\tau = 0$, we use the scaling factor ζ as an endogenous budget balancing variable in the progressive tax regime.

Consumption tax. We set $\tau^c = 8\%$ to target the consumption tax share of GDP, $\frac{\tau^c C}{Y}$, of 4.5% given $\frac{C}{Y} = 56.3\%$ as reported in the ABS 2012-2018 data.

Company profit tax. We target the company profit tax share of GDP, $\tau^k \left(\frac{Y - WL}{Y}\right) = 4.25\%$. Provided that $\frac{WL}{Y} = 1 - \alpha = 0.6$, we calculate τ^k to be 10.625%.

Means-tested Age Pension. The Australian pension system is progressive in a sense that it is independent of contribution. The scheme is also targeted because the eligibility and amount of pension benefit claimable depends on a household's income and asset levels. The Age Pension's income and assets test thresholds, and their respective taper rates are based on 2018 values. The maximum pension payout, p^{max}, is internally calibrated to be 30% of the average income Y to achieve total pension share of GDP of 3% in the benchmark steady state economy.

Family Tax Benefit and Child Care Subsidy. To capture the child-related benefit system, we fully model two major programs: (i) the Family Tax Benefit part A and part B, and (ii) the Child Care Subsidy without using parametric functional forms. There are a few reasons. First, our aim is to understand the impact of the underlying structure of the targeted and means-tested transfers on households, and therefore, we gain from the ability to explore complete models and their associated parameters (e.g., variable income test thresholds, base and maximum payment rates, withdraw rates, etc). Second, it allows for more accurate estimates of benefits eligible to households varied by their demographic and socioeconomic characteristics, economic decisions, the interplay between various household and benefit variables, and other relevant circumstances. Estimating parametric functions for the transfer programs of interest for each type combination (e.g., education, marital status, age and number of children, etc) demands a large dataset for reliability of estimation. Third, using a parametric function to estimate benefits faces the difficulties of interpretation due to the complexity of the actual scheme and the complication that arises due to the structural changes of the scheme from one year to the next. Fourth, while the FTB and the CCS constitute a significant proportion of the child-related transfer system and of the total benefit amount an eligible household may receive, their incorporation does not demand a drastic change to the structure, particularly the state space, of the model. In other words, the state elements required for the household problem can fully describe the benefit programs in place, making integrating these schemes a relatively low cost exercise.[31] Parameters for the FTB part A and part B, and the CCS are their 2018 values taken from the HILDA tax-benefit model release 19. The tax-benefit calculator is created by the Melbourne Institute for Applied Economic and Social Research. We refer interested readers to the Appendix A for more details.

[30] For the current model version, we limit our attention to the proportional income tax system by setting the progressivity parameter $\tau = 0$ and use the flat tax rate as a government budget balancing variable in all policy experiments.

[31] We are able to incorporate them into the basic model without any major changes to the structural framework including the firm's problem, the dynamics of household distributions, the aggregation of household decision variables, and the definition of the steady state competitive equilibrium.

General government expenditure and debt. We define the general government expenditure/purchase G as all government expenses - other than the two child-related transfers (FTB and CCS) and the Age Pension - not explicitly accounted for in the model . Government general expenditure in the benchmark is calculated to be 14% (total expenditure - 18.5% of GDP - net of the estimated combined expenditure on the FTB, the CCS, and the Age Pension programs - 4.5% of GDP). Similarly, public debt B is set at 20% which is close to the average public debt share of GDP.

4.6 The benchmark economy

Aggregate macro variables. We assess our model performance by comparing between model and data moments. We examine the key target and non-target aggregate macroeconomic variables in the benchmark economy. The former measures how close the benchmark is to the actual economy in terms of the targets we set to pin down our initial steady state parameters. The latter helps us determine whether the model's implications are consistent with the average real economic outcomes not targeted by the calibration procedure. On all these fronts as evident in Table 7, the model performs reasonably well, especially if we consider the match between the non-targeted data moments and those generated by our model.

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%	HILDA (2012-2018)*
		(40% $\times$ LFP)	
Consumption tax, T^C/Y	4.26%	4.50%	APH Budget Review
Corporate profit 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	HILDA (2012-2018)
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		HILDA (2012-2018)

Table 7: **Key macroeconomic variables: Model vs. Data moments**

Notes: (*) Multiple sources agree on these ranges of participation rates for mothers. (**) We set 0.35 as the target for the Gini of wage distribution at birth ($j = 1$). As a result, the male wage distribution's Gini over the entire working age is 0.3766.

Life cycle profiles. Next, we investigate the life-cycle profiles of variables of interest - for instance, the labor supply of mothers. These age-based moments require the model agents to act in a way that closely resemble how the average economic agent with similar characteristics behaves at different stages in life. Thus, they serve as good additional metrics to gauge how our model economy performs against the data.

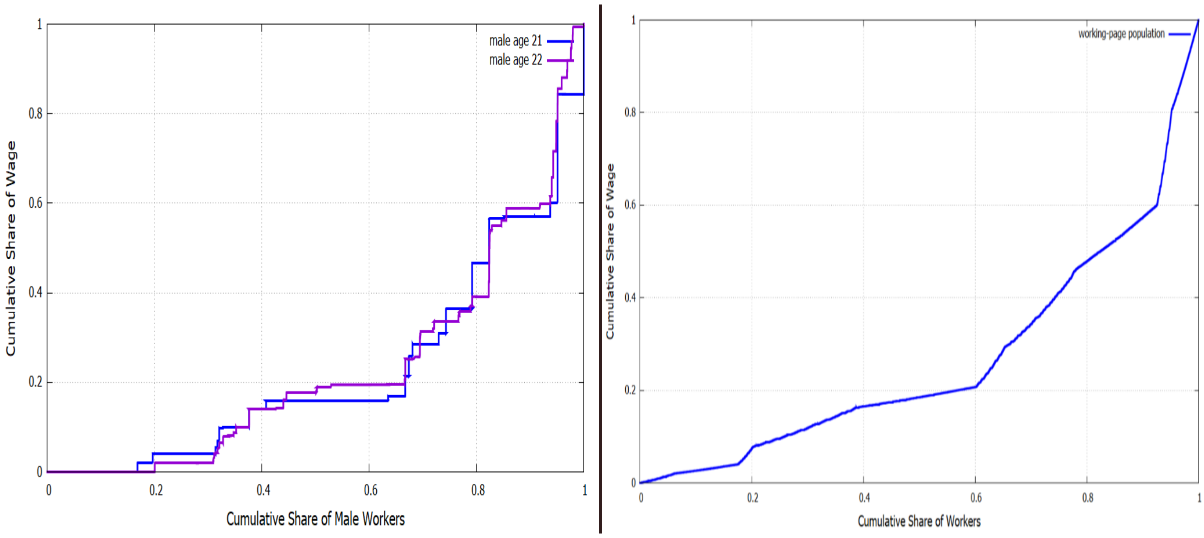

Figure 11: **Lorenz curves of wage distributions.** **Left panel:** Lorenz curves of the distributions of married male wages at age 21 and 22 (Gini = 0.35). **Right panel:** Lorenz curve of the wage distribution of working-age male population (Gini = 0.3766). Wages in the model account for human capital, education and transitory shocks over the life-cycle .

Household age-profiles of wealth suggests that a typical household wealth in the model economy peaks at roughly 6.3 times the average annual income in the initial steady state, after which the household begins the wealth decumulation process. Bequest is accidental. There is no bequest motive and thus a household living to the conclusion of its maximum lifespan will have effectively consumed all its available assets.

Age-based moments are almost impossible to match without introducing additional parameters to capture the observed or unobserved effects over the life-cycle unaccounted for in the model economy. This is especially true for the participation and full-time rates given that the intensive margin of labor supply is exogenously determined. Thus, to allow the benchmark specification to approximate the life-cycle profiles of labor force participation and full-time employment rates, we introduce a simple modification to the fixed time cost parameter. In particular, for full-time work, a fixed time cost of 0.14 (almost half of the normalized female full-time work hours) and extra time cost per child aged 0-5 years old of 0.03 are added. These values are not far off from the real setting. According to the Australian Institute of Family Studies (AIFS), mothers work 30 hours on chore and 27 hours on child care per week. If they work full-time and we make a conservative assumption that the task is split 50-50 between partners, this translates to $\dfrac{0.5 \times 57}{24 \times 7} \approx 0.17$. That is, the time cost to households associated with female full-time work, assuming men have to use their leisure time to undertake half of the household and child care duties, is 17 of the total weekly time endowment .

As for the human capital profiles, one must first take caution in interpreting them. While the male age-profile of human capital is constructed from their mean hourly wages, the endogenous female human capital profile should be interpreted as the implied return to female labor if we restrict them to participation decision along exogenously pre-determined life-cycle profiles of part-time and full-time hours. Nevertheless, it is encouraging that through endogenous female participation choice, the model economy gives rise to realistic gender human capital gap. For instance, the ABS Jobs in Australia 2011-12 to 2016-17 report shows that the median gap per employed person in the 2016-17 financial

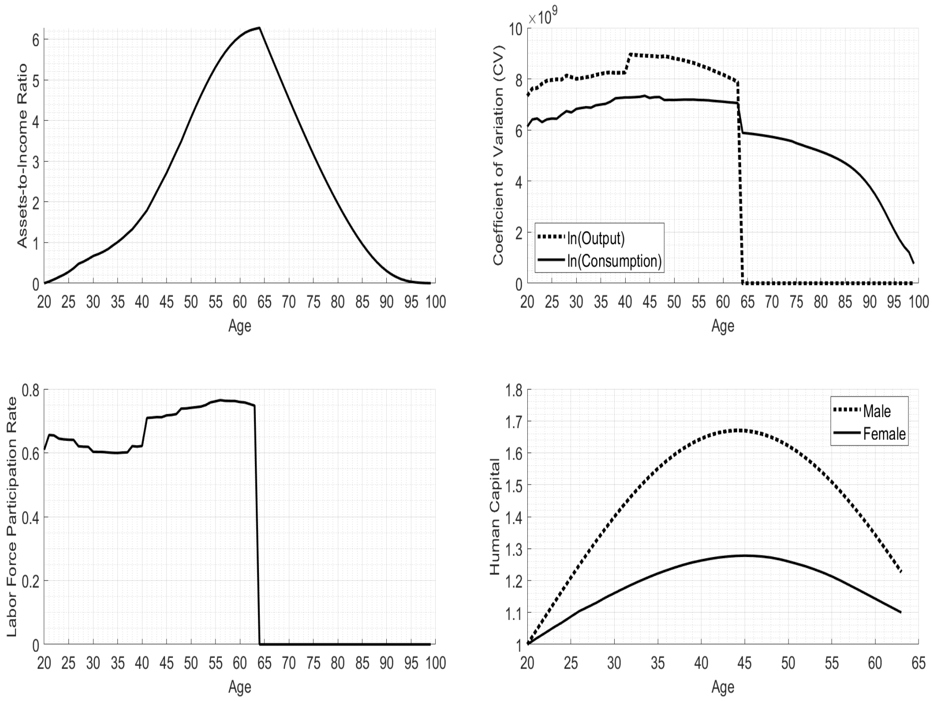

Figure 12: **Life-cycle profiles of asset holdings, coefficients of variation (CV) of log output and log consumption, female labor force participation, and human capital. Top left panel:** Life-cycle profile of assets-to-income ratio. **Top right panel:** Life-cycle profiles of CV of log output and log consumption. **Bottom left panel:** Life-cycle profile of female labor force participation rate. **Bottom right panel:** Male and female life-cycle profiles of human capital.

year is 15% for the 25-29 age group, 35% for the 35-44 group, and 25% for the 60-64 group.[32] The implied male-female human capital ratio is 1.16 for the 25-29 age group, peaking at 1.32 for the 35-44 group, and 1.14 for the 60-64 group. The mismatch for the last age group is not surprising since the model human capital path is governed by a quadratic parametric form, leading to the observed symmetry.

5 Quantitative analysis

This section discusses the model economy under different counterfactual scenarios. First, we describe the chosen policy experiments. Then, we analyze changes under these new policy regimes relative to status quo to draw lessons learned.

5.1 Alternative policy regimes

We conduct several sets of policy experiments with the focus on steady state analyses. In each new regime, we vary selected policy parameters related to one of the two programs, the FTB or the CCS, while holding other policy parameters constant. Throughout the analysis, the general government spending (net of the child-related transfers and the Age Pension) and borrowing are maintained at their initial steady-state levels using labor income tax to balance the public budget.

Specifically, we first explore the means-testing parameter space. We vary the income test thresholds across a range of taper rates of a program while keeping its payment rates and parameters of the other program at their initial stead state levels. These are detailed in Table 8 (FTB experiment 1-5) and Table 9 (CCS experiment 6-10).

The remaining experiments described in Table 10 study reforms under which the child-related transfer payment rates are changed and the means-testing parameters are kept at their status quo levels. The first two sets of experiments (11 and 12) involve contracting or expanding one of the transfer schemes by adjusting its payment rates while holding constant policy parameters associated with the other. For these experiments, both programs are to remain operative. Then, for experiment set 13, we adopt a similar procedure for 13.1 and 13.2 as in prior experiments, but instead of proportional changes to the size of a program, we eliminate it from the system. Lastly, in experiment 13.3, both policies are completely switched off. In this sense, the last set of experiments (13.1-13.3) allows us to better grasp the macroeconomic effects of an entire program in isolation and the effects of their joint presence. Furthermore, these payment rate reforms enrich our understanding of reforming the means-testing parameters through comparison between its economic implications with those generated by direct changes to the payment rates.

5.2 Results

5.2.1 Effects of reforming the FTB means-testing parameters

One of the general patterns emerging from Table 5.2.1 is that adjusting the income test thresholds is an effective means of controlling the FTB expenditure. Regardless of the taper rates, varying the thresholds causes significant changes to the size of the program. In fact, at high income thresholds

[32]See Gender wage gap statistics: a quick guide by the Australian Paraliament House (APH, 2020) and Age and the gender pay gap report by the Australian Workplace Gender Equality Agency (WGEA).

$\bar{y}^{tr}$ / ω	$0.5 \times \bar{y}^{tr}$	$\bar{y}^{tr}$	$1.5 \times \bar{y}^{tr}$
	Status quo FTB payment rates, $\{\boldsymbol{tr_j^{A1}, tr_j^{A2}}\}and\{\boldsymbol{tr_j^{B1}, tr_j^{B2}}\}$		
$0.5 \times \omega$	exp 1.1	exp 1.2	exp 1.3
$0.75 \times \omega$	exp 2.1	exp 2.2	exp 2.3
ω	exp 3.1	exp 3.2	exp 3.3
$1.25 \times \omega$	exp 4.1	exp 4.2	exp 4.3
$1.5 \times \omega$	exp 5.1	exp 5.2	exp 5.3

Table 8: **Summary of policy experiments on FTB, keeping CCS unchanged**

Notes:
Taper rates are $\{\omega_{A1}, \omega_{A2}\}$ for the FTB part A, and ω_B for the FTB part B.
Income thresholds are $\{\bar{y}^{tr}_{max}, \bar{y}^{tr}_{base}\}$ for the FTB part A, and $\{\bar{y}^{tr}_{pe}, \bar{y}^{tr}_{se}\}$ for the FTB part B.

$\bar{y}^{sr}$ / ω_{ccs}	$0.5 \times \bar{y}^{sr}$	$\bar{y}^{sr}$	$1.5 \times \bar{y}^{sr}$
	Status quo CCS statutory subsidy rates, $\{\boldsymbol{sr_1, sr_2, sr_3, sr_4}\}$		
$1.5 \times \omega_{ccs}$	exp 6.1	exp 6.2	exp 6.3
$1.25 \times \omega_{ccs}$	exp 7.1	exp 7.2	exp 7.3
ω_{ccs}	exp 8.1	exp 8.2	exp 8.3
$0.75 \times \omega_{ccs}$	exp 9.1	exp 9.2	exp 9.3
$0.5 \times \omega_{csc}$	exp 10.1	exp 10.2	exp 10.3

Table 9: **Summary of policy experiments on CCS, keeping FTB unchanged**

Notes:
Let $\omega_{ccs} = AU\$3,000$ denote the taper unit 2018. Higher taper unit is equivalent to lower taper rate, and vice versa.
See a description of the CCS scheme in subsection 4.5.
Income thresholds for the CCS are $\{\bar{y}^{sr}_1, \bar{y}^{sr}_2, \bar{y}^{sr}_3, \bar{y}^{sr}_4, \bar{y}^{sr}_5\}$ which correspond to the four statutory subsidy rates.

	FTB A	FTB B	CCS
Change FTB payment	$\{\boldsymbol{tr_j^{A1}, tr_j^{A2}}\}$	$\{\boldsymbol{tr_j^{B1}, tr_j^{B2}}\}$	
Experiment 11.1	+50%	+50%	–
Experiment 11.2	-50%	-50%	–
Change CCS rate			$\{\boldsymbol{sr_1, sr_2, sr_3, sr_4}\}$
Experiment 12.1	–	–	+50%
Experiment 12.2	–	–	-50%
Complete removal	$\{\boldsymbol{tr_j^{A1}, tr_j^{A2}}\}$	$\{\boldsymbol{tr_j^{B1}, tr_j^{B2}}\}$	$\{\boldsymbol{sr_1, sr_2, sr_3, sr_4}\}$
Experiment 13.1	-100%	-100%	–
Experiment 13.2	–	–	-100%
Experiment 13.3	-100%	-100%	-100%

Table 10: **Summary of policy experiments**

(last column of Table 5.2.1), altering the taper rates does little to change the total transfer. Not until the thresholds are sufficiently small and thus exclude more households from the FTB (left column of Table 5.2.1) do we begin to see greater effects of the taper rates on the program size.

The child-related transfer spending as a whole, however, is complicated by the presence of the CCS. Except for experiment 4.2 and 5.2 (last two rows of the middle column), the rest of the simulated economies with smaller FTB spending are always accompanied by bigger CCS spending as more women re-enter the workforce and claim child care subsidies. Therefore, if the goal is to reduce spending, letting the CCS run unhindered is bound to limit the effectiveness of FTB reforms. On the contrary, if one's aim is to increase female employment, then the existence of the CCS provides extra work incentive that boosts the reform effect.

As for the subject of work participation, results from Table 5.2.1 correspond to those from the top panel of Table 5.2.1 which shows that means testing has significant adverse effects on participation. Lowering the income test thresholds can increase the overall labor force and full-time participation rates for women up to 5.88*p.p.* and 4.13*p.p.*, respectively, relative to the pre-reform regime (exp 1.1-5.1, left column of the first panel). In a representative-agent model without family structure, we suspect more households would exit the labor force to stay below the thresholds given that the payment rates are fixed across these experiments (i.e., the program generosity has not changed). However, the existence of inelastic male partner's labor supply in conjunction with means-testing family income (for FTB A) and primary earner's income (for FTB B) implies that more households are automatically disqualified for the transfer. In this manner, eligibility criteria for public benefit no longer bind female labor supply decision, negative income effect then dominates and more married women are better off working.

Table 5.2.1 further suggests that the aggregate implications crucially depend on the taper rates of the benefit scheme. In experiment set 1-3 (top three rows of the first panel), in which benefits are withdrawn relatively slowly, changing the test thresholds in either direction increases participation, though for different reasons. Lowering the income test thresholds (exp 1.1, 2.1, 3.1) causes more participation for the reason discussed earlier, whereas raising the thresholds (exp 1.3, 2.3, 3.3) increases female participation but only in part-time for the reason that low-skilled married women can now start working part-time without losing the FTB benefit. At the same time, full-time rate falls. The larger thresholds also implies that a minority of high-skilled households has become eligible for the FTB. This causes a small fraction of high-skilled mothers to quit full-time work. On the contrary, raising the intensity at which the transfer is withdrawn via higher taper rates as done in experiment 4 and 5 (bottom two rows of the first panel) adds to the work disincentive and brings about lower participation, particularly in full-time, when the thresholds are expanded. Policies that attempt to offset the effects of large thresholds with faster benefit clawback therefore increase the work disincentive effect.

Interestingly, the response magnitudes when the thresholds expand are smaller compared with the responses when they contract. This is aligned with our findings concerning the asymmetric responses to changes in the FTB payment rates in the subsequent section 6. There are at least two plausible reasons. First, most married women susceptible to the FTB work disincentive effect have already exited the workforce.[33] Second, for experiment 4 and 5 in particular, the combination of large benefit

[33]Due to the lack of family insurance, single women's life-cycle labor supply is inelastic to the changes in benefits. Their behavior cannot explain the observed asymmetric responses.

withdrawal rates and income thresholds results in opposite responses at different stage of life-cycle. During their early years with young children, larger FTB payment rates apply. The high taper rates thus compel married women to lower their participation. Once the children have grown older and the FTB payment rates become smaller, the large thresholds encourage this same group to join the workforce. However, under the high taper rate environment, they stay in part-time work to avoid losing all the benefit. These age-varying responses partially offset one another and mitigate the reform effect of threshold expansion on the aggregate labor supply.

The increase in workforce participation drives the increase in the aggregate female human capital (or efficiency level of female labor) as seen in the second panel of Table 5.2.1. In turn, they help explain the changes in average output (or income) in the bottom panel which shows that larger increases in output generally correspond to large increases in participation and human capital.[34] On this front, lower FTB taper rates - associated with smaller adverse work incentive effect - result in greater output. Smaller thresholds also result in more participation and aggregate human capital for the reasons stated in the above discussion, and thus larger output relative to the benchmark (in the range of 1.78%-2.47% conditional on the prevailing taper rates). Hence, within our framework, more efficiency is achieved at lower taper rates and income test thresholds.

On the welfare front, the message is clear. Smaller income test thresholds and higher statutory taper rates come at the largest welfare cost to newborns relative to the pre-reform economy (see first column of Table 5.2.1). At any taper rates, enlarging the thresholds produces higher welfare gain. Similarly, fixing the thresholds, the ex-ante welfare decreases as we claw back the FTB benefit faster with higher taper rates.

In summary, maintaining the FTB payment rates and the CCS parameters at the status quo, our experiments on the FTB means-testing parameters suggest as follows. If the primary objective places a greater weight on macroeconomic efficiency and provided that male labor supply is inelastic to changes in public transfers, then the largest net gain can be attained by setting the taper rates and income test thresholds conforming to experiment 1.1 (with $0.5 \times \omega$ and $0.5 \times \bar{y}^{tr}$). At a relatively small welfare cost of 0.05%, this would lead to 5.88*p.p.* and 2.21% increases in female participation and output, respectively. However, if one desires more full-time work, then halving the thresholds and moderately increasing the taper rates (fourth row first column in the first panel of Table 5.2.1) seem to be most fruitful. The welfare outcomes across the simulated economies are less consequential. Notwithstanding, from the aggregate welfare viewpoint, experiment 1.3 - with half the taper rates and 1.5 times the FTB income test thresholds compared to their benchmark values - gives rise to the highest welfare gain of 0.68%. Note that this proximity to a universal FTB setting comes at no cost to participation and output. In fact, participation increases by 3.71*p.p.* and output increases by 1.58%, though this positive efficiency effect is not as good as the stricter means-testing cases (first and second column of Table 5.2.1). Alternatively, there is an arrangement with a more balanced outcome. Experiment 1.2, where the thresholds are at the status quo level and the taper rates are halved, increases participation by 5.08*p.p.*, human capital by 2.55%, output by 1.98% and ex-ante welfare by 0.41%.

[34]Due to the heterogeneity in the model, how potent the effect of changes to the aggregate human capital and participation is on output depends on other accompanying factors. Because each woman's productivity per unit work has to be weighted by her decision to work either part-time or full-time, the aggregate labor participation and human capital alone do not allow us to precisely determine the final output level. For this exact reason, one must consider the share of participation between low- and high-skilled women. Moreover, the hump-shaped human capital and average work hour profiles over the life-cycle also imply that the timing of work decision matters.

Taking all the different perspectives into account, our simulation exercises indicate that the new regimes from experiment set 1 are most conducive to efficiency and welfare improvement. Our results suggest that the benchmark taper rates are too strict and their adverse work incentive effects generate significant loss along the extensive margin of female labor supply. At least within the boundary of the model, regardless of one's stance on the FTB income test thresholds, the taper rates ought to be relaxed.

Status quo FTB payment rates, $\{tr_j^{A1}, tr_j^{A2}\}$and$\{tr_j^{B1}, tr_j^{B2}\}$				
ω \ $\bar{y}^{tr}$		$0.5 \times \bar{y}^{tr}$	$\bar{y}^{tr}$	$1.5 \times \bar{y}^{tr}$
$0.5 \times \omega$	FTB A	-8.16%	14.97%	37.41%
	FTB B	-42.86%	0.00%	28.57%
	CCS	16.79%	12.98%	8.40%
$0.75 \times \omega$	FTB A	-27.89%	1.36%	27.21%
	FTB B	-42.86%	-5.71%	17.14%
	CCS	18.32%	9.16%	6.11%
ω	FTB A	-38.10%	0.00%	24.49%
	FTB B	-45.71%	0.00%	14.29%
	CCS	19.85%	0.00%	4.58%
$1.25 \times \omega$	FTB A	-44.90%	-3.40%	26.53%
	FTB B	-45.71%	0.00%	20.00%
	CCS	22.90%	-0.76%	-4.58%
$1.5 \times \omega$	FTB A	-43.54%	-5.44%	25.85%
	FTB B	-40.00%	-2.86%	20.00%
	CCS	13.74%	0.00%	-5.34%

Table 11: **Percentage (%) changes in FTB A, FTB B and CCS programs**

5.2.2 Effects of reforming the CCS means-testing parameters

Table 5.2.2 illustrates the influence of the statutory taper unit and income test thresholds on the size of the CCS programs. Higher thresholds in the last column are associated with greater CCS spending, but the magnitude of changes also depends crucially on the taper unit. By definition in subsection 3.5, a lower taper unit implies a higher rate of subsidy withdrawal, and vice versa. Consequently, given income thresholds, a lower taper unit results in a smaller CCS program. However, when the income test thresholds are sufficiently strict (halved) as in experiment 6.1, 7.1 and 8.1 (first three rows first column of Table 5.2.2), raising the taper unit (thus lowering the taper rates) has little impact on the program expenditure. Nevertheless, in all cases, we see that the FTB spending always moves in the opposite direction of the CCS changes due to the interaction between the two schemes. While the former changes by smaller proportions, it is worth noting that the FTB program is larger than the CCS.

Considering the relatively smaller size and shorter time frame (for children aged 13 years old or younger) of the transfer, the impact of reforming the CCS means-testing parameters on female participation decision shown in the first panel in Table 5.2.2 is significant. Smaller CCS income test

ω \ $\bar{y}^{tr}$	Status quo FTB payment rates, $\{tr_j^{A1}, tr_j^{A2}\}$and$\{tr_j^{B1}, tr_j^{B2}\}$		
	$0.5 \times \bar{y}^{tr}$	$\bar{y}^{tr}$	$1.5 \times \bar{y}^{tr}$
LFP & FT rates			
$0.5 \times \omega$	5.88 (0.25)	5.08 (1.73)	3.71 (-0.01)
$0.75 \times \omega$	5.83 (3.19)	2.61 (1.47)	3.02 (-0.23)
ω	5.72 (3.57)	0 (0)	2.22 (-0.56)
$1.25 \times \omega$	5.56 (4.13)	-0.04 (-0.15)	-0.42 (-1.77)
$1.5 \times \omega$	3.95 (2.47)	-0.22 (-0.06)	-0.48 (-1.75)
Human Cap.			
$0.5 \times \omega$	2.72%	2.55%	1.41%
$0.75 \times \omega$	2.70%	1.56%	1.14%
ω	2.70%	0.00%	0.54%
$1.25 \times \omega$	2.70%	-0.08%	-1.24%
$1.5 \times \omega$	1.61%	-0.13%	-1.25%
Output			
$0.5 \times \omega$	2.21%	1.98%	1.58%
$0.75 \times \omega$	2.32%	1.72%	1.39%
ω	2.47%	0.00%	1.29%
$1.25 \times \omega$	2.26%	0.76%	0.34%
$1.5 \times \omega$	1.78%	0.82%	0.29%

Table 12: **Percentage point ($p.p.$) changes in labor force participation (LFP) and full-time (FT) rates, and percentage (%) changes to aggregate human capital and output.**

Notes:
Changes to full-time rates are stated in parenthesis.

ω \ $\bar{y}^{tr}$	Status quo FTB payment rates, $\{tr_j^{A1}, tr_j^{A2}\}$and$\{tr_j^{B1}, tr_j^{B2}\}$		
	$0.5 \times \bar{y}^{tr}$	$\bar{y}^{tr}$	$1.5 \times \bar{y}^{tr}$
$0.5 \times \omega$	-0.05%	0.41%	0.68%
$0.75 \times \omega$	-0.29%	0.29%	0.58%
ω	-0.44%	0.00%	0.50%
$1.25 \times \omega$	-0.73%	0.03%	0.38%
$1.5 \times \omega$	-0.79%	-0.01%	0.38%

Table 13: **Percentage (%) changes in welfare of newborns**

thresholds discourage work and result in roughly 2.5$p.p.$ less participation irrespective of the taper unit in question (see first column). Notably, the decline in participation stems primarily from full-time employment. This is because the CCS program has a work activity test component and the subsidy rate is an increasing step function of work hours of the secondary earner. The remaining experiments play out as one would expect. Reducing the taper unit increases the rate at which the subsidy is clawed back and disincentivizes work. Consequently, participation and full-time rates fall as we move down the row in the first panel of 5.2.2. Raising the CCS income test thresholds leads to more participation, primarily in full-time work, though the response magnitude is small compared with the reduction in thresholds by the same proportion. The most likely account for this asymmetric response is that married women (who make up the majority) are more inclined to reduce their participation than increasing it due to the existence of family insurance (inelastic spousal earnings) and the FTB transfer that is not conditional on participation.

Because of the reform effects on labor force participation, the aggregate human capital (second panel of Table 5.2.2) and output (third panel of Table 5.2.2) change correspondingly. As aforementioned in subsection 5.2.1, a caveat is that while participation and human capital changes are indicative of the changes in output, they do not provide complete information (see footnote 34). For example, their effects on output must first be weighted by the work hours that follow hump-shaped age profiles.

For the welfare outcome of the CCS reforms in Table 5.2.2, the gains and losses across the simulated economies are trivial. Cutting the thresholds results in ex-ante welfare losses, by at most 0.02% (first column of Table 5.2.2). Provided that the FTB parameters and the CCS subsidy rates are kept at their status quo levels, larger means test thresholds $\bar{y}^{sr}$ and smaller rate of withdrawal via higher taper unit ω_{ccs} seem to produce positive welfare changes, though the largest gain is only 0.1%. The negligible impact on welfare could stem from two reasons. First, when the CCS contracts, the presence of the FTB insures most households against consumption loss. Second, when the CCS expands, the effect on the income tax rate (i.e., tax burden) is offset by the reduction in the FTB size, the larger tax base and aggregate human capital as more women enter the workforce.

Hence, a CCS reform that prioritizes efficiency is a reasonable pursuit. If we want to maximize output, then maintaining the status quo taper unit and increasing the income test thresholds as demonstrated in experiment 8.3 yields the greatest output gain of 1.37% (third row third column in the last panel of Table 5.2.2). The associated changes are 0.67$p.p.$ increase in participation (0.55$p.p.$ in full-time) and ex-ante welfare gain of 0.1% which also happens to be the largest across the experiments conducted on the CCS means-testing parameters.

6 Extension

6.1 Effects of reforming the FTB payment rates

Experiment 11.1 and 11.2 adjust the FTB part A and part B payment rate parameters, keeping the FTB means-testing parameters and the entire CCS scheme at their origin.

We begin with experiment 11.1 in which we increase the per child base and maximum payment rates $\{tr_j^{A1}, tr_j^{A2}\}$ for the FTB A and the per family benefit payment rates $\{tr_j^{A1}, tr_j^{A2}\}$ for the FTB B by 50%. The experiment yields rich results. Increasing the benefit by 50% leads to 1.1% less aggregate output relative to the benchmark. This is largely due to the 3.48$p.p.$ lower female labor force participation - half of which comes from the decline in full-time rate - driven by (i) the extra work

ω \ $\bar{y}^{tr}$		$0.5 \times \bar{y}^{sr}$	$\bar{y}^{sr}$	$1.5 \times \bar{y}^{sr}$
		Status quo CCS statutory subsidy rates, $\{sr_1, sr_2, sr_3, sr_4\}$		
$1.5 \times \omega_{ccs}$	FTB A	3.40%	-0.68%	-2.72%
	FTB B	2.86%	0.00%	0.00%
	CCS	-48.09%	6.87%	32.06%
$1.25 \times \omega_{ccs}$	FTB A	3.40%	-0.68%	-2.72%
	FTB B	2.86%	0.00%	0.00%
	CCS	-48.85%	3.82%	29.77%
ω_{ccs}	FTB A	3.40%	0.00%	-2.04%
	FTB B	2.86%	0.00%	0.00%
	CCS	-49.62%	0.00%	24.43%
$0.75 \times \omega_{ccs}$	FTB A	3.40%	1.36%	-2.04%
	FTB B	2.86%	0.00%	0.00%
	CCS	-52.67%	-9.16%	20.61%
$0.5 \times \omega_{csc}$	FTB A	4.08%	2.04%	-3.40%
	FTB B	2.86%	2.86%	-2.86%
	CCS	-55.73%	-12.98%	18.32%

Table 14: **Percentage (%) changes in FTB A, FTB B and CCS programs**

ω_{ccs} \ $\bar{y}^{sr}$	$0.5 \times \bar{y}^{sr}$	$\bar{y}^{sr}$	$1.5 \times \bar{y}^{sr}$
	Status quo CCS statutory subsidy rates, $\{sr_1, sr_2, sr_3, sr_4\}$		
LFP & FT rates			
$1.5 \times \omega_{ccs}$	-2.46 (-2.12)	0.36 (0.06)	0.75 (0.68)
$1.25 \times \omega_{ccs}$	-2.49 (-2.19)	0.29 (-0.02)	0.74 (0.83)
ω_{ccs}	-2.48 (-2.16)	0 (0)	0.67 (0.55)
$0.75 \times \omega_{ccs}$	-2.50 (-2.33)	-1.67 (-0.71)	0.63 (0.71)
$0.5 \times \omega_{csc}$	-2.67 (-2.45)	-1.86 (-1.02)	1.02 (0.83)
Human Cap.			
$1.5 \times \omega_{ccs}$	-1.50%	0.11%	0.37%
$1.25 \times \omega_{ccs}$	-1.52%	0.08%	0.38%
ω_{ccs}	-1.53%	0%	0.34%
$0.75 \times \omega_{ccs}$	-1.56%	-0.81%	0.39%
$0.5 \times \omega_{csc}$	-1.66%	-0.95%	0.70%
Output			
$1.5 \times \omega_{ccs}$	-0.22%	0.87%	0.99%
$1.25 \times \omega_{ccs}$	-0.14%	0.86%	1.15%
ω_{ccs}	-0.13%	0%	1.37%
$0.75 \times \omega_{ccs}$	-0.05%	0.43%	1.21%
$0.5 \times \omega_{csc}$	-0.15%	0.33%	1.26%

Table 15: **Percentage point (*p.p.*) changes in labor force participation (LFP) and full-time (FT) rates, and percentage (%) changes to aggregate human capital and output.**

Notes:
Changes to full-time rates are stated in parenthesis.

ω_{ccs} \ $\bar{y}^{sr}$	$0.5 \times \bar{y}^{sr}$	$\bar{y}^{sr}$	$1.5 \times \bar{y}^{sr}$
	Status quo CCS statutory subsidy rates, $\{\boldsymbol{sr_1, sr_2, sr_3, sr_4}\}$		
$1.5 \times \omega_{ccs}$	-0.0154%	0.0893%	0.0519%
$1.25 \times \omega_{ccs}$	-0.0009%	0.0879%	0.0847%
ω_{ccs}	-0.0050%	0%	0.1007%
$0.75 \times \omega_{ccs}$	0.0131%	0.0383%	0.0801%
$0.5 \times \omega_{csc}$	-0.02%	0.02%	0.08%

Table 16: **Percentage (%) changes in welfare of newborns**

disincentive effect from the bigger benefits, (ii) the time cost of child care, and (iii) the inelastic male labor supply in married households who account for the majority of the population.[35] Consumption falls by 1.81%, more than proportional the drop in income. However, ex-ante welfare effect as measured by the Hicksian Equivalent Variation (HEV) goes up by 0.83%, which implies that the greater leisure time enjoyed by the newborn households in the post-reform period more than compensates them for the loss in consumption.

Despite the apparent complexity of the scheme and life-cycle factors, expanding the payment rates effectively enlarges the FTB spending by roughly the same proportion, 50%. What is surprising at first glance is that income tax rate increases by only 1.48*p.p.* in spite of the larger FTB, smaller consumption (thus, smaller consumption tax) and lower participation (thus, smaller income tax base). Upon closer inspection, one can see that this is thanks to the decline in the CCS expense by 12.12% as more women exit the labor force and become disqualified for the subsidy. Another channel mitigating the tax burden is that the increased tax rate is also levied on men whose labor supply is inelastic and whose earnings paths are on average higher than those of women.

Moreover, because the FTB serves as insurance against future mortality and earnings risks, its expansion causes households to save less for self-insurance against future uncertainties. In addition to the lower average income, this means more households accumulate less wealth and end up passing the means tests for the Age Pension when they retire (extensive margin). The public spending on pension however decreases by 0.31% because the maximum pension benefit claimable per pensioner (intensive margin) falls as it is pegged to prevailing average income in the model economy. These two forces (more beneficiaries at a lower payout) offset one another such that the change in the Age Pension is trivial relative to the change in the CCS (13 times smaller); therefore, a smaller effect on the budget-balancing income tax.

The factors aforementioned come together and counteract the negative fiscal effect of the larger FTB spending. A key lesson is that unlike traditional models featuring a single welfare program, the tax burden here is alleviated by the interplay between related and seemingly unrelated transfer programs (abstracting from administrative overhead) through their direct or indirect effects on household decision variables such as labor supply and savings. As a result, insofar as both programs remain operative and only one undergoes a reform, the general equilibrium effect on labor supply operating via the income tax channel tends to be of secondary concern. In other words, the predicted tax burden on female participation would have likely been overstated had we disregarded these crucial policy interactions. It also implies that a huge response from non-parents (e.g., single childless men

[35] These three factors exert the greatest adverse work incentive effect on low-skilled married mothers whose early arrival of children and lower net return to labor make work even more unattractive. Consequently, the observed aggregate change in participation stems almost entirely from the decline in participation by low-skilled married mothers.

in the model) would be unlikely even if we made their labor supply endogenous.

Another noteworthy finding is the asymmetric response to different reform directions. In experiment 11.2, downsizing the FTB payment rates by 50% raises female participation by 6.83*p.p.*, approximately twice the magnitude of the decrease in participation from experiment 11.1 in which the FTB is expanded by the same proportion. That is, compared with an increase in the FTB, cutting back on the benefit by the same proportion generates more responses in the absolute sense. Such asymmetry is easily missed in reduced-form models. A plausible reason is that with the current scheme, more households are closer to the tipping point of the entry-exit decision when benefits are reduced than when they are raised.[36] Another possibility is that in the benchmark economy, most mothers susceptible to the work disincentive effect of the FTB have already exited the labor force. The extra adverse work incentive effect might therefore diminish as the FTB increases.

	Pre-reform	Experiment 11.1. (+50% FTB)	Experiment 11.2. (-50% FTB)
	Benchmark values	Change	Change
Income (Y)	1.1325	-1.11%	1.09%
Consumption (C)	0.6009	-1.81%	2.30%
Savings (S)	0.0711	-3.75%	4.22%
Female LFP	0.6355	-3.48 p.p.	6.83 p.p.
Female FT rate	0.2402	-1.85 p.p.	5.51 p.p.
Income tax rate	19.7720	1.48 p.p.	-1.15 p.p.
Tax revenue	0.2392	4.52%	0.33%
FTB expense	0.0183	49.90%	-49.34%
CCS expense	0.0130	-12.12%	37.40%
Pension	0.0382	-0.31%	0.11%
HEV (newborn)	–	+0.83%	-1.00%

Table 17: **Experiment set 11: Family Tax Benefit**

6.2 Effects of reforming the CCS subsidy rates

For better understanding the efficiency and welfare effects of the CCS, we conduct two reforms on the CCS statutory subsidy rates, and fix the FTB parameters and the CCS means-testing parameters at their initial values. In the first reform or experiment 12.1, the CCS subsidy rates are increased by 50%, and vice versa for the second reform or experiment 12.2.[37]

Experiment 12.1 demonstrates that increasing the CCS statutory subsidy rates by 50 brings about a 75.4 increase in size of the CCS program. Because the CCS subsidizes the cost of child care for children aged 13 years old or younger, households with young children are the main beneficiaries from the larger subsidy. Consequently, the CCS expansion incentivizes more mothers aged below 45 to join the workforce, which results in a 7.61*p.p.* jump in the female participation rate, with 4.29*p.p.* entering

[36] When the FTB is cut, the tipping point refers when the marginal value gain of a household (whose female member stays at home in the initial economy) from having its female member work outweighs the marginal value gain from staying at home, and vice versa when the FTB is raised.

[37] Note that the statutory subsidy rates are the maximum rates if both parents work at least 48 hours per week. A subsequent adjustment is made via the work activity test to determine the effective subsidy rate.

full-time work.[38] We also see output and consumption increase by 1.33 and 2.05, respectively, due to the larger workforce.

Once again, the interplay between the FTB and the CCS programs plays an important role. The 50% rise in the CCS rates induces a reduction in the FTB claim by 14.24% as more young mothers work and become ineligible or eligible for lower FTB benefits. Because the FTB is 1.6 times the size of the CCS in the benchmark economy, the decreased FTB spending (ignoring the trivial increase in the Age Pension) is sufficient to help lower the tax burden. Furthermore, although expanding the CCS causes a 5.31% increase in the tax revenue to maintain a balanced government budget, it encourages more young married mothers (whose households comprise 70% of the model population) to enter the workforce and has the effect of raising female labor efficiency as human capital potential (expressed as human capital accumulate rate) is largest at early working age. In turn, the improved labor efficiency leads to higher tax receipt per female worker. Accordingly, the required budget-balancing income tax rate increases by a meager $0.61p.p.$ and does not lead to a significant secondary effect on the female labor supply.[39]

A more revealing comparison of policy relevance is between the 50% contraction of the FTB (experiment 11.2) from the previous subsection and the 50% expansion of the CCS (experiment 12.1) we have just discussed. These regime shifts yield similar macroeconomic outcomes in efficiency terms. While expanding the CCS rates is slightly more effective in increasing the general participation and scaling back the FTB encourages a bit more full-time work, their magnitudes are comparable. Likewise, their effects on aggregate income, consumption and income tax rate are close. These reforms are thus quite similar in their aggregate efficiency effects. However, the larger CCS actually leads to a small ex-ante welfare gain of 0.1% for all newborn households, whereas shrinking the FTB entails a welfare loss of 1%.

Given that consumption and leisure decrease by comparable magnitudes in both experiments, these factors cannot account for the observed difference in welfare outcome. To our knowledge, there are two plausible sources of explanation. First, the FTB insures households against longevity and earnings risks, and therefore, increases the stability of consumption growth over their life-cycle. This adds to the ex-ante welfare, and helps explain the 4.22% jump in domestic savings when the FTB benefit falls.[40] Second, the inclusion of rudimentary family structure substantially influences the welfare implication of a reform. In an economy where all agents are identical with respect to their self-insurance (e.g., through work and savings) and family insurance (e.g., spousal earnings) capabilities, reducing or even abolishing the FTB in favor of a less targeted regime would likely result in welfare gains. In our model economy, on the contrary, family insurance for single mothers, most of whom are already working part-time, is absent. Taking away some FTB benefit inevitably compels them to either work full-time at a high fixed time cost of child care, or remain in part-time at the cost of lower consumption. The same can be said for low-skilled married mothers who are matched with low-skilled partners from birth; hence, having less secured family insurance. These factors help account for the

[38] Provided that the first child is born to a low-skilled mother aged 21 and the last child of every high-skilled mother arrives at age 31, the oldest mother with a child aged 13 years old in our economy is 44 years old.

[39] Based on the Australian government's Budget strategy and outlook: budget paper no. 1: 2018-19 page 6-26, the FTB is 2.6 times the size of the CCS. This is not a target moment for our model. The current model's implied ratio is a result of household heterogeneity and decisions under limited family types (single childless men, single mothers, and married parents) and understates the actual ratio by overstating the CCS expense. We believe further improvement could be made with richer heterogeneity and endogenous intensive margin of labor supply decision.

[40] The CCS, on the contrary, has a relatively small insurance role. As we will show in the next section, even a complete elimination of the CCS results in a small impact on the variation of consumption growth.

1% welfare loss associated with experiment 11.2 despite the lower tax rate and higher consumption. An important determinant of the welfare outcome in this context is therefore how reforms affect the self-insurance ability. The presence of the CCS ensures that self-insurance via market participation is less costly to single mothers since some fraction of the child care fee is covered by the scheme.[41]

Turning to Experiment 12.2 in the second column of Table 18, we witness asymmetric responses as shown in subsection 6.1. Compared with the absolute changes produced by expanding the CCS program (7.61*p.p.* increase in total participation), cutting the CCS statutory rates by 50 causes the female participation to fall by a smaller magnitudes (4.26*p.p.*). The CCS spending falls by 64.62, and the total FTB disbursement rises by 7.61. Aggregate output, consumption and savings decline by 0.46%, 1.41% and 4.64%,respectively. The negative effect on savings - most probably a result of lower income and more FTB beneficiaries in the newly simulated economy - reduces the average household assets level. What follows is more households becoming eligible for the Age Pension, and the total pension spending increases by 3.66%. The resultant increased FTB and Age Pension spending counteracts the favorable effect of the smaller CCS on the tax burden. The saved tax revenue of 2.47% materializes in the form of 0.55*p.p.*, which is smaller than it would otherwise be in the absence of transfer program interactions.. Ultimately, experiment 12.2 is a lose-lose policy change as both efficiency and welfare decline under this regime.

Our study does not seek to provide an optimal combination of policies; notwithstanding, the comparability between these experiments seems to suggest a potential win-win (welfare and efficiency improving) reform avenue via expansion of the CCS, conditional on the status quo CCS means-testing and FTB parameters being maintained. In other words, if one is given a choice between contracting the FTB or expanding the CCS, the findings in this subsection indicate that the latter is a better alternative.

	Benchmark	Experiment 12.1. (+50% CCS)	Experiment 12.2 (-50% CCS)
Output (Y)	1.1325	1.33%	-0.46%
Consumption (C)	0.6009	2.05%	-1.41%
Savings (S)	0.0711	1.13%	-4.64%
Female LFP	0.6355	7.61 p.p.	-4.26 p.p.
Female FT rate	0.2402	4.29 p.p.	-4.50 p.p.
Income tax rate	19.7720	0.61 p.p.	-0.55 p.p.
Tax revenue	0.2392	5.31%	-2.47%
FTB expense	0.0183	-14.24%	7.61%
CCS expense	0.0130	75.38%	-64.62%
Pension	0.0382	1.31%	3.66%
HEV (newborn)	–	0.1%	-0.02%

Table 18: **Experiment set 12: Child Care Subsidy**

[41]Reducing the FTB, provided that the CCS remains unchanged, has a relatively small negative effect on welfare. As we will demonstrate in subsection 6.3, eliminating the FTB and the CCS altogether is equivalent to taking away not just the government insurance but also the self-insurance from single mothers. With no family insurance as a buffer, this policy move results in a severe welfare loss for this demographic group.

6.3 Effects of eliminating the FTB and the CCS

Experiment 13.1 in Table 19 removes entirely the FTB and keeps the CCS parameters at their initial steady state levels. The accompanying stronger incentive to work leads to 10.58*p.p.* more women joining the workforce. The full-time rate increases even more, by 11.18*p.p.*, which indicates that a portion of the increase comes from the pre-reform female part-time workers switching to full-time in the post-reform economy. One direct consequence is a 79.23% larger CCS program. On the condition that the government general purchase and borrowing are fixed, changes to the FTB and the CCS constitute the only major changes to the expenditure side of the public budget. The CCS is however substantially smaller than the FTB. As a result, the expanded CCS scheme is not enough to cancel the tax revenue saving effect of the the FTB elimination which leads to a 1.72*p.p.* fall in the income tax rate. What this finding suggests is that even under extreme reform scenarios, the interplay between transfer programs still reduces by a significant degree the general equilibrium effect via income tax rate on household behavior.

Furthermore, because the FTB constitutes a source of insurance against longevity and idiosyncratic earnings risks, its removal is equivalent to a loss of an important government insurance instrument, and substantially increases the aggregate savings by 16.03%. This has the effect of thinning the mass of eligible households for the Age Pension program; thereby, lowering the pension spending by 3.14.

We can follow the same reasoning procedure to arrive at an analogous interpretation for results pertaining to experiment 13.2 - in which only the CCS scheme is eliminated. Instead, we turn our attention to some insights that emerge from this extended explorations.

Reform intensity and aggregate outcome. Comparing experiment 13.1 with 11.2 of subsection 6.1, we find strikingly similar macroeconomic implications despite the more drastic reform associated with the former. In particular, even when the FTB is removed completely, the corresponding increases in output, consumption, and income tax rate are comparable size-wise to their counterparts realized in the scenario where the FTB is scaled back by 50%. The latter regime leads to a 1.15*p.p.* lower income tax rate, whereas the former causes a 1.72*p.p.* reduction. This is not a large difference, but it is somewhat expected given that the accompanying increase in the CCS spending for the total FTB elimination is 79.23%, more than double the increase associated with the less drastic FTB reform. It suggests that as long as the policy parameters of the CCS are held constant, we should not see any large change in the income tax rate regardless of how big the reduction to the FTB is.

Perhaps more perplexing is the aggregate output which in experiment 11.2 and 13.1 alike increases by approximately 1%. In other words, the output gain from completely removing the FTB labor supply distortion is not significantly different from what we would get with halving the program. Although the former increases total participation by 10.58*p.p.* and full-time work by 11.18*p.p.*, approximately twice the magnitudes of the corresponding increases for the latter, this addition to the labor force comes from mostly (i) low-skilled mothers who have low innate return to labor by assumption, and/or (ii) married mothers who have not enough time to build human capital in their early life phase due to child care responsibilities and work disincentive effect stemming from the inelastic husband's labor supply (family insurance). This translates into small output contribution and aggregate macroeconomic effect for the total elimination of the FTB program. More importantly, it points at a diminishing efficiency effect of the reform; that is, the efficiency outcome in terms of output and consumption does not necessarily improve proportionally with the intensity of a reform.

Policy ranking exercise. Prior discussion signals a potential direction for improvement. In the

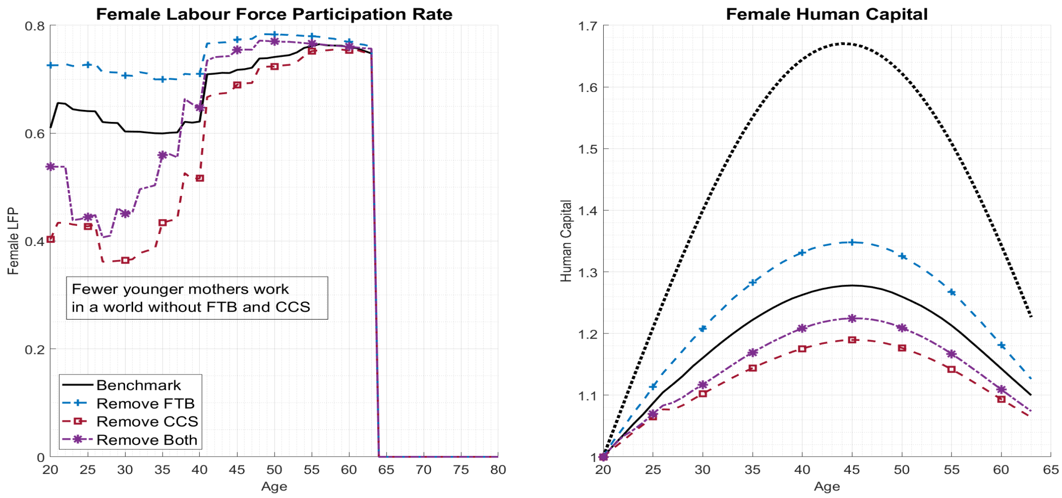

Figure 13: **Reform effects on female labor force participation and human capital accumulation. Left panel:** Life-cycle profile of female labor force participation rate. **Right panel:** Male and female life-cycle profiles of human capital.

counterfactual experiment 13.2, removing the CCS alone has the most adverse efficiency impact. A key factor driving this loss is the presence of the FTB, which in the absence of the CCS, makes the stay-at-home option more appealing to more mothers. It results in a drop of 10*p.p.* for the female labor force participation, around half (4.55*p.p.*) of which comes from full-time. The tax rate only falls by 0.7*p.p.* partly due to the rise in the FTB beneficiaries. In overall, we see a 3.26% decrease in aggregate consumption and a 3.48% decrease in output, but the availability of the FTB keeps the welfare loss at a relatively small value of 1%.

On the other hand, removing the FTB and keeping the CCS active at the status quo - as in experiment 13.1 - has a more favorable efficiency effect. The change increases female participation by a considerable margin of 10.58*p.p.* relative to the status quo, and its effect is even more potent on full-time work. The tax burden on all agents falls and output rises by roughly 1%. This new regime is therefore better efficiency-wise. In contrast, the FTB, a direct means-testing child-related transfer, plays an important government insurance role against longevity and earnings risks. Evident in Figure 14, a complete removal the CCS only increases the variation of consumption growth over the life-cycle - as depicted by the age-profile of the coefficient of variation (CV) of log consumption - by a relatively small degree over a 10-year period between age 30 and 40 when most parents have young children. On the contrary, eliminating the FTB has large and prolonged negative effect on the CV of log consumption. Thanks to the loss of this government insurance, particularly for single and low-skilled married mothers who lack family insurance and self-insurance ability, the new regime under experiment 13.1 incurs about 5.5 loss to the welfare of newborn households.

This finding, in conjunction with the earlier comparison between experiment 13.1 and 11.2, marks the first lesson on policy ranking. Restricting our concern to the payment rates, if one wishes for more female participation (particularly in full-time) via the FTB reform route, then eliminating the FTB in experiment 13.1 generates the most bang. It doubles the effect in experiment 11.2. On the contrary, this move generates a relatively high ex-ante welfare loss, and its efficacy with respect to boosting aggregate output and consumption is almost indistinguishable from its less drastic policy counterpart from 11.2. Given the extreme nature of 13.1, a more holistic view advocates the practice of lowering the FTB benefits instead of a total removal. Even better, if we allow the CCS reform to be within our policy horizon, then raising the CCS rates as shown in experiment 12.1 generates the most well-rounded outcome at a relatively small increase of 0.61*p.p.* in the tax burden. That is, its effect on participation, output and consumption is similar to that achieved by the 50% FTB contraction. What differentiates experiment 12.1 from the rest is that there is no unfavorable welfare trade-off since it also increases the welfare of newborns by 0.1%.

Transfer program interaction and efficiency. If we were to ignore welfare loss in a setting with family structure and program interaction as we showcase in this study, an important question to ponder is whether abolishing both child-related transfers could produce greater efficiency gain. Experiment 13.3 shows that this is not necessarily the case. Removing the FTB and the CCS altogether does not generate the desirable efficiency effect, which seems to defy the view that getting rid of distortive transfers would augment economic efficiency. This is because of the net positive effect of the combined child-related transfers on young mothers' participation. While the FTB leads to fewer full-time workers, the CCS effect dominates in encouraging more part-time work. On the whole, the model suggests the current female labor supply is greater than it would be otherwise were both programs absent, as shown by the life-cycle profiles of female labor force participation on the left panel of Figure 13. Consequently, eliminating both policies reduces total female participation by 2.31*p.p.*, and here lies a puzzle. Although the participation falls by a relatively small fraction, the drop in output is 3.05% in experiment 13.3 which is considerable given that an alternative economy in experiment 13.2 with a much larger 10*p.p.* participation loss gives rise to only a 3.48% output decline. The driving mechanisms appear to be the life-cycle dynamics of human capital and the responses by households to reforms conditional on skill type. When both programs are removed, low- and high-skilled young mothers (between 20 and 35 years of age) respond by exiting the workforce, which leads to a drastic decline in participation at early age (see the left panel of Figure 13).[42] However, due to the absence of government insurance, the stronger incentive to save against income and longevity risks (i.e., consumption smoothing motive) and the lower tax burden, the labor supply recovery is just as quick such that after age 35, their participation in the counterfactual economy 13.3 stays above that of the initial steady state level. Due to the total removal of the FTB, the recovery in experiment 13.3 is also faster than that in experiment 13.2 such that the entire life-cycle profile of participation for women in the former economy stays above its counterpart in the latter. This combination of the drastic fall in participation when young and the quick turnaround contributes to the smaller change in participation of 2.31*p.p.* in relation to the benchmark level and experiment 13.2.[43] As to why it brings about a relatively large decline in output is partly related to the hump-shaped life-cycle profile of human capital. The accumulation rate is largest when a female worker is young and declines as she ages. For this reason, exiting the labor force during the early stage of her prime working age incurs a significant loss of human capital potential (or, labor efficiency) that culminates in the relatively large

[42]Note that, because the CCS targets families with children of age 13 years old or younger, the CCS leads to higher participation for young mothers who would build up human capital in early life but exit the labor force once the CCS has expired and the stronger FTB effect kicks in. The CCS keeps young mothers in the workforce during the period when their human capital accumulation rate is at its highest.

[43]A complete withdrawal of both programs also removes the policy interaction effect and produces a greater effect on the budget-balancing income tax rate. The rise in aggregate savings that leads to a sizeable reduction in pension spending further lowers the tax burden. In contrast, the smaller income and income tax base, and the lower aggregate consumption (thus, lower consumption tax) place some burden on the income tax system. Ultimately, the combined forces still cause the the income tax rate to fall by 4.22%, but it is not sufficient to offset the work disincentive effect of the reform on women.

fall of output. There are also other driving factors. Getting rid of both policies spurs more reaction from low-skilled mothers with relatively low output contribution at the cost of lower participation from a fraction of high-skilled women, who in the absence of subsidy, can afford to exit the labor force thanks to the presence of family insurance from high-skilled partners. Aggregate statistics can therefore be hard to make sense of, and elements of heterogeneity in the model help us better comprehend the policy questions at hand.

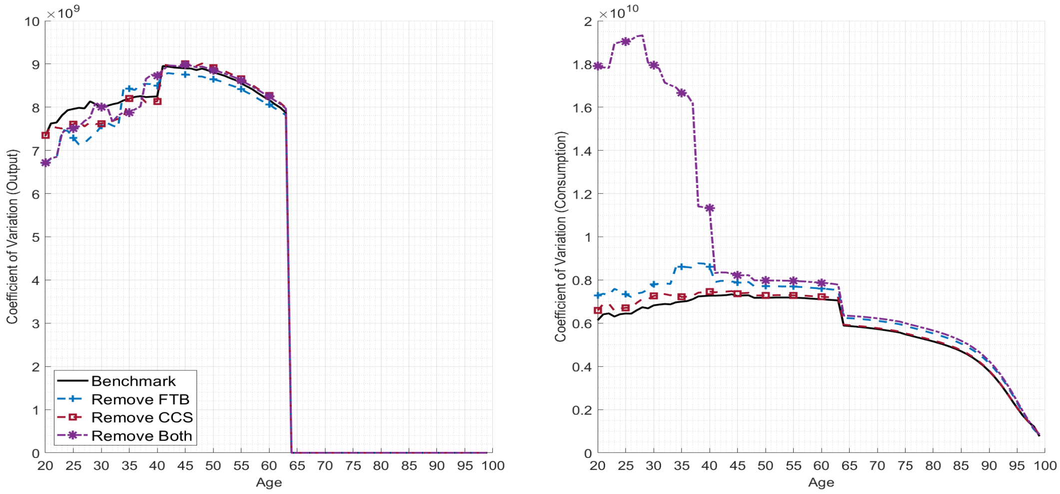

Figure 14: **Reform effects on coefficients of variation of log output and log consumption.** **Left panel:** Life cycle profile of coefficient of variation of log output. **Right panel:** Life cycle profile of coefficient of variation of log consumption.

Child-related transfers, family structure and ex-ante welfare. Compared with a model without family structure, there are lots of similarities with respect to the economic outcome of a reform. A notable exception is the welfare effect when all child-related support programs are removed. In a model that does not distinguish between family types, households have equal capabilities to self-insure by working and saving more in response to the elimination of policies. Differently, in a model as ours that features heterogeneity in family structure and children, high-skilled married women come out ahead due to the presence of family insurance and assortative mating. Low-skilled mothers, especially those who are single, confront a huge time cost to their leisure in addition to the pecuniary child care cost which limit their self-insurance ability. The lack of efficacious family mechanism to insure against risks means that in a policy-less economy, this group typically sticks to part-time work at the cost of lower per capita consumption for their households, or works full-time at the cost of formal child care service fee and a substantial portion of their time endowment. Consider first the scenarios from experiment 13.1 and 13.2 in Table 19. Experiment 13.1 removes government insurance but supports the act of self-insurance through the provision of the CCS. On the other hand, removing the CCS in experiment 13.2 makes work more costly, but the self-insurance is simply replaced by the government insurance via the FTB. In either case, some form of insurance is maintained. In contrast, eliminating both programs is tantamount to reducing self-insurance on top of eliminating government insurance. Because single and low-skilled mothers (married to low-skilled partners by assumption of assortative matching) lack family insurance, they tend to experience the greatest loss of welfare under this kind of reform. At a broader level, the forgone targeted benefit is indeed converted into a lower tax burden that is spread across working households. But, as per our discussion, income tax is just a small part of the cost of participation and is unlikely to offset the ex-ante welfare loss associated with the reform for single mothers. Accounting for family structure allows the model to reflect this fact through the large negative welfare effect as evident in experiment 13.3.

	Pre-reform	Experiment 13.1. (removing FTB)	Experiment 13.2. (removing CCS)	Experiment 13.3. (remove both)
	Benchmark values	% Change	% Change	% Change
Income (Y)	1.1325	1.01%	-3.48%	-3.05%
Consumption (C)	0.6009	1.43%	-3.26%	-2.31%
Savings (S)	0.0711	16.03%	-1.41%	18.99%
Female LFP	0.6355	10.58 p.p.	-10.00 p.p.	-2.31 p.p.
Female FT rate	0.2402	11.18 p.p.	-4.55 p.p.	0.26 p.p.
Income tax rate	19.7720	-1.72 p.p.	-0.70 p.p.	-4.22 p.p.
Tax revenue	0.2392	-1.46%	-5.27%	-14.05%
FTB expense	0.0183	-100.00%	10.89%	-100.00%
CCS expense	0.0130	79.23%	-100.00%	-100.00%
Pension	0.0382	-3.14%	-3.93%	-8.12%
HEV (newborn)	–	-5.5021%	-1.00%	-51.46%

Table 19: **Experiment set 13: Family Tax Benefit and Child Care Subsidy**

7 Conclusion

This paper marks the first attempt to cast two major child-related transfers based on the Australian targeted welfare design - the Family Tax Benefits and the Child Care Subsidy - into a general equilibrium heterogeneous-agent overlapping generations model to examine their aggregate efficiency and welfare implications. Through multiple steady state analyses relative to the benchmark economy calibrated to Australia 2012-18, we were able to (i) decompose the individual effects of the mean-testing and payment rate parameters of each program, (ii) better understand how these parameters interact within a program and how different programs interact, and (iii) how life-cycle factors and demographic heterogeneity affect policy reform outcome.

A caveat is that this result abstracts from labor market frictions that might prevent immediate labor supply response (and cause unemployment), and political frictions that might impede the automatic adjustment of one program in response to the change of another. Neither is there any administrative overhead that exacerbates the inefficiency of having multiple complex support programs running head-to-head in a single welfare system. We also do not encode intensive margin of labor supply into the household decision problem, and therefore, the results cannot capture smaller labor supply responses. In addition, while we argue that the effect of tax burden on male labor supply may be small and thus the exogenous male labor supply assumption is innocuous, married men may still have the incentive to insure households against risks when income falls under extreme reforms to the public support system. This would influence the degree of participation by women. Moreover, the model economy abstracts childless married households and childless single women. These groups would enjoy significant gains from the lower tax burden. Nonetheless, the interplay between the FTB and the CCS is such that the net effect of policy changes on the income tax is small across the simulated economies, barring the one where we get rid of both programs. Furthermore, fertility, education, and marriage - especially for low-income households - could be adversely affected by policies (e.g., transfers could encourage divorce and discourage investment in education). Although the model is silent on the incentive effect on education, our results show that certain reforms (e.g., expanding the FTB) lowers female human capital trajectories in the learning-by-doing sense. For fertility and marriage, we assume they are exogenous which preclude any household response on these fronts. With regards to welfare analysis, the current study does not account for the full transitional dynamics between steady states to capture the welfare effect on non-newborn generations living in the reform period (who, upon birth, have committed to optimal decision paths and are shocked by the reforms we introduce).

In any case, the stated assumptions allow for tractability and thus construction of a macroeconomic model with large state space and family structure in conjunction with the unique configuration of the Australian child-related transfer policies. The model has proved its worth by eliciting insights that would have otherwise been missed in more traditional settings. We show that means-testing is an effective instrument to control the transfer spending on par with direct changes to the payment rates. However, they are accompanied by strong work disincentive effects. The findings suggest potential improving reforms. All else constant, either (i) lowering the FTB taper rates, (ii) relaxing the CCS income test thresholds, or (iii) raising the CCS payment rates seems to be a more well-rounded option in terms of efficiency and welfare improvement, though the resultant welfare increase can be small. In addition, our work generates important lessons learned beyond the questions posed at the outset. First, it demonstrates that the inclusion of family structure into quantitative work can make a difference to the efficiency and welfare analysis, and therefore policy recommendations. Second, understanding the life-cycle impact of a reform is crucial in making sense of the aggregate statistics. Last but not least, one should not consider a policy reform in isolation. Policies interact such that the removal of a policy does not necessarily remove the tax burden. At least within the confines of our model, efficiency gain is not a guaranteed outcome in the absence of all policies.

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Appendix

A Child-related transfer programs in Australia

The Australian tax and transfer system consists of progressives income taxes and highly targeted transfers. The core components of the Australian income tax system includes a progressive income tax schedule with statutory marginal tax rates, deductions, concessions, offsets and levies. The progressive tax schedule is applied to combined taxable income. Government transfers are often subject to complex rules of means testing with different benefit levels, income and asset thresholds, and taper rates. There are two main transfer programs to families with children: Family Tax Benefit (FTB) and Child Care Subsidy (CCS). Family Tax Benefit has two parts as described below:

A.1 Family Tax Benefit part A (FTB A)

The FTB A program is a non-taxable transfer paid per child and the amount claimable depends on family's circumstances. In short, it is a function of combined household adjusted taxable income, annual private rent, and age and number of dependent children. Important parameters that determine the levels, kinks and slopes of the FTB A benefit schedule are:

1. Statutory base and maximum payment rates per qualifying dependent child (i.e., FTB child),
2. Income test thresholds for the base and maximum payments,
3. Withdrawal or taper rates for the base and maximum payments, and
4. Supplements such as the Large Family Supplement (LFS), the Newborn Supplement (NBS), the Multiple Birth Allowance (MBA), the Rent Assistance (RA), and the Clean Energy Supplement (CES) that are added to the statutory base and maximum payment rates per child to derive the total base and maximum payments. We provide formulae for calculating these supplements in the subsequent subsections.

Rent Assistance (RA): Rent assistance adds to the per child maximum payment of the FTB A and is available only to FTB A recipients who rent privately which we assume to hold true for all households in the benchmark model.

$$RA_j(rent) = \begin{cases} MAX\{MIN\{0.75\,(rent - rent_{min}),\ RA_{max}\},\ 0\} & \text{if } FTBA_1 \geq FTBA_{min} \\ 0 & \text{otherwise} \end{cases} \tag{A.1}$$

Where $rent$ is the annual rent, $rent_{min}$ is the minimum rent to qualify for the RA, RA_{max} is the cap on the RA benefit, $FTBA_1$ is the FTB A benefit excluding the RA, $FTBA_{min}$ is the minimum size of the FTB A for which a household must be qualified to be deemed eligible for the RA.

Before 2013, $FTBA_{min}$ is set to the base FTB A payment and $FTBA_{min} = 0$ thereafter. In 2018, expressed in 2018 AU$

$$RA_{max} = \mathbf{1}_{\{ndep_{[0,24],j} \leq 2\}} 4,116.84 + \mathbf{1}_{\{ndep_{[0,24],j} \geq 3\}} 4,648.28\}$$

$$rent_{min} = \mathbf{1}_{\{single=1\}}4,102.28 + \mathbf{1}_{\{couple=1\}}6,071.52$$

A.2 Family Tax Benefit part B (FTB B)

The FTB B program is paid per family. Its objective is to give additional support to single parents and single-earner partnered parents with limited means. Similar to the FTB A, the FTB B is a function of age and number of dependent children, but differently, the eligibility and amount claimable are determined by separate tests on spouses' (i.e., primary earner's and secondary earner's) individual taxable income and marital status of the potential recipients. Important parameters that determine the levels, kinks and slopes of the FTB B benefit schedule are: (i) Maximum payment rate; (ii) Separate income test thresholds on primary and secondary earners; and (iii) Withdrawal or taper rates based on secondary earner's taxable income

Let $y_{pe} = MAX(y_{\tau,h},\ y_{\tau,w})$ and $y_{se} = MIN(y_{\tau,h},\ y_{\tau,w})$ denote the primary earner's and secondary earner's taxable income, respectively, and let $m_{B_i,j} = FTBB_{max_i} + CES_{B,j}$ be the maximum payment per family. Note that the structure of the FTB B changed in 2017. The FTB B formula prior to 2017 is thus different to that from 2017 forward. That is,

Before 2017

$$FTBB_j(y_{\tau,h}, y_{\tau,w}) = \begin{cases} cond_1 \times m_{B_1,j} + cond_2 \times m_{B_2,j} & \text{if } y_{pe} \le FTBB_{T_1} \text{and } y_{se} \le FTBB_{T_2} \\ & \\ cond_1 \times MAX\{0,\ m_{B_1,j} - FTBB_w(y_{se} - FTBB_{T_2})\} & \text{if } y_{pe} \le FTBB_{T_1} \text{and } y_{se} > FTBB_{T_2} \\ +cond_2 \times MAX\{0,\ m_{B_2,j} - FTBB_w(y_{se} - FTBB_{T_2})\} & \end{cases} \tag{A.2}$$

From 2017

$$FTBB_j(y_{\tau,h}, y_{\tau,w}) = \begin{cases} cond_1 \times m_{B_1,j} + cond_3 \times m_{B_2,j} & \text{if } y_{pe} \le FTBB_{T_1} \text{and } y_{se} \le FTBB_{T_2} \\ & \\ cond_1 \times MAX\{0,\ m_{B_1,j} - FTBB_w(y_{se} - FTBB_{T_2})\} & \text{if } y_{pe} \le FTBB_{T_1} \text{and } y_{se} > FTBB_{T_2} \\ +cond_3 \times MAX\{0,\ m_{B_2,j} - FTBB_w(y_{se} - FTBB_{T_2})\} & \end{cases} \tag{A.3}$$

Where $cond_1 = 1_{\{ndep_{[0,4],j} \ge 1\}}$, $cond_2 = 1_{\{ndep_{[0,4],j}=0,\,(ndep_{[5,15],j} \ge 1 \text{ or } ndep_{[16,18]_{AS},j} \ge 1)\}}$ and $cond_3 = 1_{\{ndep_{[0,4],j}=0,\,ndep_{[5,12],j} \ge 1\}} + 1_{\{ndep_{[0,4],j}=0,\,ndep_{[5,12],j}=0,\,(ndep_{[13,15],j} \ge 1 \text{ or } ndep_{[16,18]_{AS},j} \ge 1),\ single=1\}}$

A.3 Child Care Subsidy (CCS)

The Child Care Subsidy program aims at assisting households with the cost of caring for children aged 13 or younger who are not attending secondary school and is paid directly to approved child care service providers. Eligibility criteria include (i) a test on the combined family income (y_{hh}), (ii) the type of child care service, (iii) age of the dependent child, and (iv) hours of recognized activities (e.g., working, volunteering and job seeking) by parents (n_j^h, n_j^w). The rate of subsidy is also determined by parameters such as income thresholds, work hours, and taper unit (the size of income increment by which the subsidy rate falls by 1 percentage point). Given that the current model is silent on the type of child care and therefore child care fees, we assume the followings:

1. Identical child care service operating within a perfectly competitive framework,
2. No annual cap on hourly fee and on subsidy per child,[44]
3. Households exhaust all the available hours of subsidized care.

The child care subsidy function is

$$CCS(y_{\tau,hh}, n_j^h, n_j^w) = \Psi(y_{\tau,hh}, n_j^h, n_j^w) \times \begin{cases} CCS_{R_1} & \text{if } y_{\tau,hh} \leq TH_1 \\ MAX\{CCS_{R_2},\ CCS_{R_1} - \omega_1\} & \text{if } TH_1 < y_{\tau,hh} < TH_2 \\ CCS_{R_2} & \text{if } TH_2 \leq y_{\tau,hh} < TH_3 \\ MAX\{CCS_{R_3},\ CCS_{R_2} - \omega_3\} & \text{if } TH_3 \leq y_{\tau,hh} < TH_4 \\ CCS_{R_3} & \text{if } TH_4 \leq y_{\tau,hh} < TH_5 \\ CCS_{R_4} & \text{if } y_{\tau,hh} \geq TH_5 \end{cases} \tag{A.4}$$

Where $y_{\tau,hh} = y_h + y_w + ra$ and $\omega_i = \dfrac{y_{\tau,hh} - TH_i}{taper\ unit}$.
In 2018,

- Taper unit = AU$3,000;
- Statutory subsidy rates, $CCS_R = \{0.85,\ 0.5,\ 0.2,\ 0\}$;
- Income test thresholds in 2018 AU$, $TH = \{70,015;\ 175,015;\ 254,305;\ 344,305;\ 354,305\}$;
- Let $n_j^{min} = min\{n_j^h, n_j^w\}$. The adjustment factor is

  $$\Psi(y_{\tau,hh}, n_j^h, n_j^w) = 0.24_{\{y_{\tau,hh} \leq AU\$70{,}015,\ n_j^{min} \leq 8\}} + 0.36_{\{8 < n_j^{min} \leq 16\}} + 0.72_{\{16 < n_j^{min} \leq 48\}} + 1_{\{n_j^{min} > 48\}}$$

  Otherwise, $\Psi(y_{\tau,hh}, n_j^h, n_j^w) = 0$.

B Solution method and algorithm

We proceed in the following steps. First, we solve the model (a small economy with open capital market) for its initial balanced-growth path steady state equilibrium which is calibrated to the Australian economy's key micro and macro economic moments in the period 2012-2018 (a relatively stable period for these moment values). With the benchmark economy in place, we conduct sensitivity analysis and policy experiments by solving static problems for final steady state equilibria of hypothetical alternative economic regimes. The algorithm is as follows:

1. Parameterize the model and discretize the asset space $a \in [a_{min}, a_{max}]$. The choice of grid points is such that
   - Number of grid points, $N_A = 70$;
   - $a_{min} = 0$ (No-borrowing constraint);

[44] On 10 December 2021, the annual cap for all families who get CCS was removed. For further detail, see the Australian depart of education's announcement.

- The grid nodes on $[a_{min}, a_{max}]$ are fairly dense on the left tail so households are not restricted by an all-or-nothing decision (i.e., unable to save early in the life cycle due to the lack of choices on the grid nodes for small asset levels);
- a_{max} is sufficiently large so that: (i) household wealth accumulation is not artificially bound by a_{max}, and (ii) there is enough margin for upward adjustment induced by new policy regimes;

2. In a similar manner, discretize the human capital space $h^f_{\lambda,\ell} \in [h^f_{min,\lambda,\ell}, h^f_{max,\lambda,\ell}]$ for each λ and ℓ types such that
   - Number of grid nodes, $N_H = 25$;
   - $h^f_{min,\lambda,\ell} = 1$ for all λ and ℓ;[45]
   - $h^f_{max,\lambda=0,\ell} = h^m_{max,\lambda=0,\ell}$ and $h^f_{max,\lambda=2,\ell} = h^m_{max,\lambda=1,\ell}$ for every ℓ;
3. Guess the initial steady state values of endogenous aggregate macro variables K_0 and L_0, endogenous government policy variables, and wage (w), taking $r = r^w$ where r^w is a given world interest rate;
4. Solve the representative firm problem's first-order conditions for market clearing factor prices;
5. Given the vector of the benchmark economy's macro and micro parameters (Ω_0), the parameters governing the stochastic processes of lifespan (ψ) and income (η_m, η_f), factor prices (w, r), and the government policy parameters, solve for the household problems for optimal decision rules on savings (a^+), joint consumption (c), female labor force participation (ℓ) and the value function of households by backward induction (from $j = J$ to $j = 1$) using *value function iteration* method;
6. Starting from a known distribution of newborns ($j = 1$), compute the measure of households across states by forward induction, using
   - the computed decision rules $\{a^+_j, c_j, \ell_j\}^J_{j=1}$;
   - the time-invariant survival probabilities $\{\psi\}^J_{j=1}$;
   - the Markov transition probabilities of the transitory earnings shocks η;
   - the law of motion of female human capital from equation 5;

   For determining the next period measure of households on the asset (a) and female human capital (h) grids, we employ a linear interpolation method on their next period values;
7. Accounting for the share of alive agents, sum across all state elements to get the aggregate levels of savings (A), consumption (C), female labor force participation (LFP), tax revenue, transfers, and others. Update L, K, I and Y via a convex updating process to ensure a stable convergence. Solve for endogenous government policy variables using the government budget balance equation.

[45] An alternative method is to set $h^f_{min,\lambda,\ell} = h^m_{min,\lambda,\ell}$. In plain English, we set the minimum earnings abilities of single and married female working in part-time or full-time jobs to match those of their male counterparts. This would be more realistic but could cause erratic labor supply responses to policies at the beginning, most likely owing to the fact that we have no job switching friction/cost. We are exploring different options in subsequent developments.

8. Given the updated aggregate variables, calculate the goods market convergence criterion for a small open economy

$$Y \quad - \quad (C + I + G + NX) < \varepsilon$$

where

- the trade balance NX at time t is the difference between current and future government foreign debts. That is, $NX_t = (1+n)(1+g)B_{F,t+1} - (1+r)B_{F,t}$ and $B_{F,t} = A_t - K_t - B_t - B_{LSRA,t}$ is the required foreign capital to clear the domestic capital market;
- $NX < 0$ implies a capital account surplus or current account deficit (net inflow of foreign capital and thus an increase in the foreign indebtedness).[46]

9. Return to step 3 until the goods market convergence criterion is satisfied.

Our steady-state analysis is capable of capturing the ex-ante welfare effect of a regime shift (i.e., effect on the future newborns). However, grasping the full impact of a policy change requires that one also investigates the welfare effect of the change on current generations (non-newborn) alive in the reform period. This requires that we consider the dynamics of the problem in-between steady states by solving for the transition path of the model economy as it moves from the initial steady state under the status quo to the final steady state equilibrium under the new regime. For a problem like ours with high dimensionality, this is a computationally monumental task. One might need to impose simplifying parametric forms on the social security schemes of interest, and/or shrink the state space by re-formulating certain aspects of the problem. For this study, only the steady state results are shown.

[46] B_{LSRA} is the debt level of the Lump Sum Redistributive Authority whose sole purpose is to completely compensate (*tax*) the existing cohorts for their losses (*gains*) by using tax revenue from (*compensat*ing) the newborn cohorts for their gains (*losses*) due to the new policy regime in our policy experiment while maintaining a zero net present value of the LSRA's lifetime budget. Any net surplus in resource after the scheme is concluded can be regarded as an aggregate efficiency gain resulting from the policy experiment, and vice versa. For the current exercise, however, $LSRA$ is silent and thus $B_{LSRA} = 0$.

C Main tables and figures

C.1 Tables

	+50% FTB	+50% CCS	-50% FTB	-50% CCS
	Change	Change	Change	Change
Income (Y)	-1.11%	1.33%	1.09%	-0.46%
Consumption (C)	-1.81%	2.05%	2.30%	-1.41%
Savings (S)	-3.75%	1.13%	4.22%	-4.64%
Female LFP	-3.48 p.p.	7.61 p.p.	6.83 p.p.	-4.26 p.p.
Female FT rate	-1.85 p.p.	4.29 p.p.	5.51 p.p.	-4.50 p.p.
Income tax rate	1.48%	0.61%	-1.15%	-0.55%
Tax revenue	4.52%	5.31%	0.33%	-2.47%
FTB expense	49.90%	-14.24%	-49.34%	7.61%
CCS expense	-12.12%	75.38%	37.40%	-64.62%
Pension	-0.31%	1.31%	0.11%	3.66%
HEV (newborn)	+0.83%	+0.10%	-1.00%	-0.02%

Table C.1: **Changes relative to the benchmark values**

Financial year	Welfare ($b)	Welfare-GDP (%)	Welfare-Revenue (%)
2010-11	140.19	8.43	34.04
2011-12	149.66	8.70	34.20
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	8.80	31.18
2019-20	195.71	9.86	36.05

Table C.2: **Welfare expenditure in Australia**

Notes: $ value is expressed in 2019–20 prices.
Source: Welfare expenditure report by the Australian Institute of Health and Welfare.

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

Table C.3: **Welfare expenditure to GDP (%) by target groups**

Source: Welfare expenditure report by the Australian Institute of Health and Welfare.