Aggregate Implications of Child-Related Transfers with Means Testing*

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Abstract

Should government transfers to families with children be means-tested or universal? We revisit this question and provide new insights from the Australian policy settings where family earnings and demographic characteristics determine eligibility and benefit of the child-related transfers. We first document key empirical facts on the child care programs and the distinct age-profiles of mothers' labor supply in Australia. Next, we build a dynamic general equilibrium overlapping generations model of single and married households with children to quantify the implications of the status quo means-tested system and potential reforms for female labor supply, macro aggregates, and welfare. Our results indicate that strict and complex benchmark means-test rules can result in significant adverse effects on female labor supply and human capital accumulation. A universal child-related transfer system improves the aggregate efficiency and welfare and is supported by the majority; however, the resultant high tax burden leads to a welfare loss for single mothers who are the intended beneficiaries. A simple incremental increase of the child care subsidy rate can boost both efficiency and welfare, while also achieving a more equitable distribution of welfare gain. However, this approach yields a lesser overall welfare improvement compared to the universal scheme and lacks majority support.

JEL: E62, H24, H31

Keywords: Child-Related Transfers; Means-Testing; Universal Transfers; Female Labor Supply; Welfare; Dynamic General Equilibrium

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1 Introduction

Governments in advanced economies implement child benefit policies to support low-income families with dependent children, namely child-related transfers, but the structures of these policies vary significantly, leading to debates in academic research and policy making spheres. The transfers—including child care subsidies, child tax credits, and lump-sum transfers, just to name a few—are typically either universal or means-tested. In practice, the OECD countries generally adopt the means testing approach, though they may vary in terms of their definition of means, and auxiliary test instruments such as demographic and socioeconomic criteria. Australia, in particular, has a long history of implementing a means-tested child-related transfer system with the following distinct features: (i) lump-sum benefits independent of labor force status and formal child care subsidy for working parents; and (ii) family income test and demographic criteria (e.g., marital status, and number and age of children) as the central policy tools to target low-income families and control the number of recipients (extensive margin) as well as the benefit level (intensive margin). More recently, several countries, including the United Kingdom and the United States, have also incorporated income tests into their child-related transfer programs.[1]

Means testing is essential for delivering benefits to families in need and controlling expenditure. Meanwhile, it can produce significant work disincentives. For this reason, questions pertaining to how to improve existing child-related transfer programs and/or design an optimal system have been a subject of macro and public finance literature. Previous studies examine the macroeconomic impact of child-related transfers in the US policy settings (e.g., Guner, Kaygusuz and Ventura 2020). In this paper, we extend that literature by providing new insights from a study of the Australian design.

We begin by providing key motivating statistics from the household survey data, HILDA 2001-2020, and the 2021 Child Care Package Evaluation by Bray et al. 2021. We highlight three key empirical facts: (i) child-related transfers are important for low income parents; (ii) life cycle labor supply profiles of mothers have distinct features, such as the M-shaped full-time employment share profile, which set them apart from men and childless women; and (iii) there are large earning discrepancies between mothers and non-mothers.

Next, we formulate a simple partial equilibrium model to highlight how the inclusion of means testing into a child-related transfer program can affect labor supply decision. We then develop a dynamic general equilibrium overlapping generations model of single and married households facing income and longevity risks, time and monetary costs of raising children, and unequal access to child-related transfers due to means testing. Our model households are also heterogeneous in terms of parental status, number and age of children, asset holdings, education, human capital, uninsurable individual income shocks, and government transfers. Married households make joint decisions on female workforce participation, consumption, and savings over the life cycle. There are two major government transfer programs supporting households with dependent children, namely (i) Family Tax Benefit (FTB) - a direct lump sum transfer independent of workforce participation - and (ii) Child Care Subsidy (CCS) - a subsidy to the formal child care cost for working parents. We discipline our benchmark model using macro aggregates and household microdata from Australia. The calibrated

[1] Australia has been running a means-tested child-related transfer system since the introduction of the New Tax System (Family Assistance) Act 1999. The UK incorporated income test into its child-related benefit after the High Income Child Benefit Charge 2013. Not long ago, the United States introduced income test to phase out child tax credits for high income families according to the American Rescue Plan Act 2021.

model is used to quantitatively assess the impacts of the status quo regime and potential reforms on female labor supply, macro aggregates, welfare and redistribution of welfare (or, equity). To this end, we use per capita output as a proxy for efficiency, and employ a Hicksian Equivalent Variation method (detailed in Subsection 4.9) to measure welfare changes. We conduct counterfactual analyses by varying policy parameters of the aforementioned programs and use income tax as a budget-balancing variable, holding behavioral and other policy parameters at their initial steady state values. Our main results are summarized as follows.

In our first set of experiments, we compare steady state results between the benchmark economy and the counterfactuals which involve abolishing either (i) the FTB, (ii) the CCS, or (iii) both. The first and third experiments generate output gains from more female workforce participation and human capital at the cost of welfare. Eliminating all programs in the third experiment leads to a significant efficiency gain with a relatively small welfare cost. However, the adverse welfare consequence disproportionately affects single mothers who have no family insurance and whose ability to self-insure against future earnings risk is limited by the pecuniary and non-pecuniary penalties of child care. The second experiment offers no gain. Removing the CCS, which supports self-insurance, is a lose-lose policy. The CCS-free economy experiences a large reduction in labor supply and human capital. In addition, it enlarges the FTB program, thus imposing a significant tax burden that offsets the tax alleviation effect of the CCS removal and leads to a moderate welfare loss. In other words, the FTB transfer is fulfilling its government insurance role in the absence of the CCS, but its positive welfare effect is ultimately outweighed by the consequent depressed disposable earnings for the average household. These results emphasize the ever-present trade-offs between efficiency and welfare in policy design. Overall, the negative welfare effects of removing either one or both child-related transfer programs are dominant. Based on the welfare perspective in our framework, we conclude that child-related transfers are socially desirable.

We then turn to the question of whether a universal program is a better mechanism in terms of efficiency, welfare and distribution of welfare changes (or, equity) for delivering child benefits. We find means-testing that can have significant work disincentive effects as its phase-out rates raise the effective marginal tax rates (EMTRs) for its beneficiaries. Universalizing the system can be efficiency and welfare improving, and the reform is supported by the majority of our model agents. However, the aggregate effects mask the significant welfare redistribution underneath. First, while the universal system indeed removes some of the downsides of means-testing, it lacks the ability to restrain the fiscal costs. More specifically, a universal program with the same payment rates as the baseline means-tested FTB and CCS significantly increases the public spending on child support. Second, when taking the life cycle view, because the transfers rapidly decline as children get older, they are not adequate replacements for the income and human capital earned through work, especially for single mothers. As a result, the substantial tax burden associated with this radical reform diminishes the welfare of single mothers, the intended beneficiaries who rely on self-insurance once they exit the child transfer scheme.

Lastly, we extend the analysis to selected cases of incremental reforms to the means-test parameters and the universal transfer rate. For the means-test reform, we consider changes to either the FTB payment rate, the CCS subsidy rate, or their taper rates. The results demonstrate that most of these reforms involve efficiency and welfare trade-offs. The single exception is when the CCS taper rates are relaxed (halved) which generates an overall efficiency gain and moderate welfare benefits for all households. Compared to the universal scheme, this new regime improves efficiency and welfare without sacrificing equity. Conversely, the aggregate welfare gain is smaller and married households, who constitute the majority, benefit less relative to what the universal program has to offer. This suggests that although an incremental reform could lead to a modest but fair gain, the baseline universal child-related transfers would still secure the most votes if both policy options were presented.

For the second set of experiments, we examine alternative universal regimes by varying the payment rate. We find that deviating from the baseline payment rates neither addresses the inequity issue nor achieves the program's aim to benefit all parents. On the one hand, scaling up the universal program entails a heavy tax burden and exacerbates the financial strain on single mothers as already explained. On the other hand, a downsize alleviates the said burden on single mothers, but the smaller payment rates adversely affect low-education married households. Family size and early parenthood limit the young low-income parents' capacity to self-insure via work. Simultaneously, credit constraint prevents them from self-insuring via borrowing against their future earnings. Consequently, low-income parents have large marginal utilities of consumption early in life, and this might justify the need for government transfers to relax their constraints and allow them to better smooth their life cycle consumption. A smaller universal payment than the baseline rate fails to fulfill this role. In conclusion, within the scope of our investigation and considering the life cycle perspective, our quantitative results suggest that means-testing is a necessary tool for delivering benefits to target groups, even though the universal system may enhance overall efficiency and welfare.

Related literature. This paper is related to a strand of literature on female labor supply (e.g., see Baker, Gruber and Milligan 2008; Guner, Kaygusuz and Ventura 2012*a*; Guner, Kaygusuz and Ventura (2012*b*); Bick 2016; Bick and Fuchs-Schündeln 2018). Guner, Kaygusuz and Ventura (2012*a*) and Guner, Kaygusuz and Ventura (2012*b*), for instance, model joint labor supply of married couples and study the disincentive effect of joint-taxation in the US. Bick and Fuchs-Schündeln 2018 study the implications of taxation for the cross-country married men's and women's work hour differences across 17 European countries and the US. Recent development also focuses on the joint benefits of social security (e.g., Kaygusuz 2015; Nishiyama 2019; Borella, De Nardi and Yang 2020) and child-related transfers (e.g., Guner, Kaygusuz and Ventura 2020). Our paper contributes to this growing literature by providing a first quantitative study of the Australian case, where income is taxed separately but child-related transfers are strictly means-tested based on joint income. In terms of methodology, we extend the model in Guner, Kaygusuz and Ventura 2020 to have male and female earnings and mortality risks. We also explore a wide range of experiments involving radical and incremental reforms of the child-related transfers and examine their trade-offs across three primary objectives: efficiency, welfare, and redistribution (equity).

This study also contributes to the literature on means-tested social insurance (e.g., Hubbard, Skinner and Zeldes 1995; Feldstein 1987; Neumark and Powers 2000; Tran and Woodland 2014; Braun, Kopecky and Koreshkova 2017). Their findings suggest that means-testing distorts incentives to work and save, but can be useful for balancing the insurance and incentive trade-offs and result in an overall welfare improvement. We extend the literature and demonstrate similar mechanisms at work for government transfers to families with dependent children. In addition, we show that even when the universal system is an overall improvement to the means-testing system and favored by the majority, it can still conceal undesirable redistributive effects that go against policy objectives.

Finally, our paper is related to the empirical literature on labor supply in Australia (e.g., see

Doiron and Kalb 2005; Gong and Breunig 2017; Iskhakov and Keane 2021; Hérault and Kalb 2022). We are motivated by such empirical facts and build a structural macro model to study macroeconomic implications. Our paper also contributes to the growing body of studies on the impacts of fiscal policies in Australia (e.g., see Tran and Woodland 2014; Kudrna, Tran and Woodland 2022; Tran and Zakariyya 2022; Tin and Tran 2023).

The paper hereinafter proceeds as follows. Section 2 presents some stylized facts. Section 3 discusses a simple theoretical model constructed for intuitions. Section 4 gives a full description of the dynamic general equilibrium model. Section 5 reports the internal and external calibration procedures, and the benchmark economy's performance. Section 6 discusses selected counterfactual analyses. Section 7 concludes. The Appendix provides additional results and descriptive statistics, detailed information on the child-related transfer programs, and the algorithm to solve the model.

2 Child-related transfers and life cycle labor supply in Australia

In this section, we provide brief institutional features of the two child-related transfer programs and selected empirical life cycle labor supply facts based on the Household, Income and Labour Dynamics in Australia (HILDA) Survey Restricted Release 20 (2001 – 2020) and the 2021 Child Care Package Evaluation by Bray et al. 2021. These serve as motivating factors and evidence to support subsequent discussion.

2.1 Family Tax Benefit (FTB) and Child Care Subsidy (CCS) programs

Transfers directed towards families with children, or child-related transfers, in Australia represented between 2-2.5 of GDP over the past decade. These transfers are highly targeted with emphasis on supporting low-income, single-earner couple parents and single parents. The support is delivered through a range of instruments, such as strict means-testing measures on joint and secondary earner's income, along with adjustable payment rates and income-test thresholds according to the number and age of dependent children. Two programs take center stage: the Family Tax Benefit (FTB) and the Child Care Subsidy (CCS), constituting 70% of the total child-related transfer expense.[2]

Both the FTB and the CCS are subject to means-testing and vary based on on the number and age of dependent children. The FTB, a direct lump-sum transfer, does not require labor market participation and consists of two parts. The FTB part A (FTB-A) tests joint income. Its maximum and base payments per child scale with the number of dependent children and are at their highest for households with young children. The FTB part B (FTB-B) tests primary earner's income to determine eligibility (extensive margin) and secondary earner's income to determine payment and taper rates (intensive margin). The FTB-B benefit is paid per family, and similar to the FTB-A, families with younger children receive higher payments.

The CCS program is the core product of the 'Child Care Package' reform in 2018 that involved significant additional government spending. The CCS subsidizes the cost of formal child care services (paid directly to the service providers), including out of school hours care (OSHC) for children up to 13 years old, and uses means testing on family income to determine the subsidy rate. A distinctive feature of the CCS, setting it apart from the FTB, is the activity test on secondary earner's work hours

[2]See Table C.2 in the Appendix and the Budget Paper 1: Budget Strategy and Outlook page 6-26.

to adjust the income-test-based subsidy rate. Parents who work, or engage in recognized activities like training or volunteering, for 48 hours or more per fortnight can receive subsidies covering up to 85% of the formal child care costs. The income-test-based subsidy rate is scaled down as work hours fall.

In summary, the FTB is a means-tested transfer to parents with no labor market conditions attached, whereas the CCS helps reduce child care costs for working parents. Furthermore, a significant segment of the FTB parents uses child care services, as evident in Figure 1 which shows the proportion of children in child care by child age and FTB status of parents. The child care usage profiles are roughly hump-shaped for both FTB and non-FTB recipients, and the greatest incidence of child care usage occurs during the first 5 years from birth. Single FTB parents in particular have the highest proportion of children in child care across all ages. Because the FTB and the CCS benefits are not mutually exclusive, this warrants an investigation into their joint effects and potential reforms.

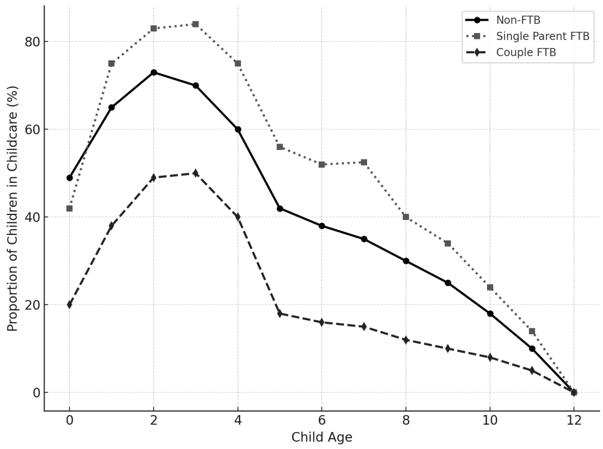

Figure 1: **Proportion of children in child care by child age and FTB receipt**
Source: Data is based on Figure 95 of the Child Care Package Evaluation: Final Report, 2021.. Figure 95 uses Q2 2019 (June 2019) DESE and DSS administrative data, ABS National, State and Territory Population Cat No 3101.0

Enabled by the availability of data on the FTB parameters and its recipients from HILDA, we first delve into the FTB's evolution over the past two decades. We then provide some key facts on the CCS based on the 2021 Child Care Package Evaluation Final Report by Bray et al. 2021. Appendix A gives a comprehensive breakdown of the two program formulae, including benefit calculation methods, qualification criteria, and how payment rates vary based on marital and parental status, the number and age of children and household income.

The FTB-A

The proportion of households receiving the FTB-A (out of all households observed in the survey data) has been falling from 10% in 2001 to slightly over 5% in 2020, as shown in Figure A.3 in the Appendix. This extensive margin decline can be attributed, in part, to threshold-creep (inflation pushing income up above the income-test threshold) and the falling birth rate.[3] Despite the falling aggregate, the benefit is concentrated among low-income families. The left panel of Figure 2 suggests

[3]The base thresholds for FTB-A (determining the benefit phase-out zone) are not indexed to inflation. During the latter half of the 2010s, its thresholds for maximum and base payments hovered around $\$50,000$ and $\$95,000$ (current AUD), respectively. Within the same period, the taper rates stood at about 0.2 for the maximum payment and 0.3 for the base payment (see Figure A.1 and Figure A.2).

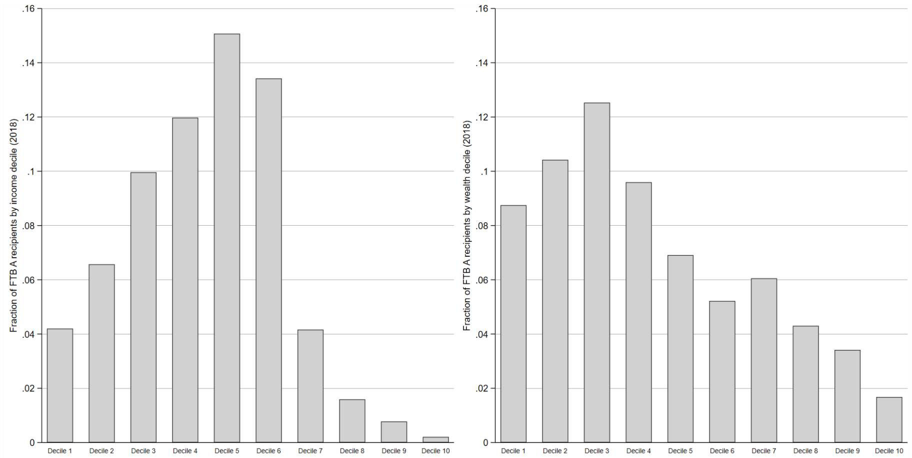

Figure 2: **Fractions of FTB-A recipients in 2018 by income and wealth deciles**

a sizeable fraction of households in the first six income deciles received for the FTB-A in 2018 (up to 15 for the median households). Surprisingly, plausibly due to the lack of assets test, relatively wealthy households also passed the eligibility criteria from the benefit as portrayed in the right panel.[4] Because the benefit extends to families around the median income and wealth, it inevitably raises their effective marginal tax rates (EMTRs) and potentially leads to low or lower-middle income trap if the payment is sufficiently large to influence work incentive. That said, Figure 8 on the life cycle facts indicates that the share of FTB is inconsequential for those in the third income quintile. However, it might be a concern if the FTB expands and the benefit for the eligible upper income households increases.

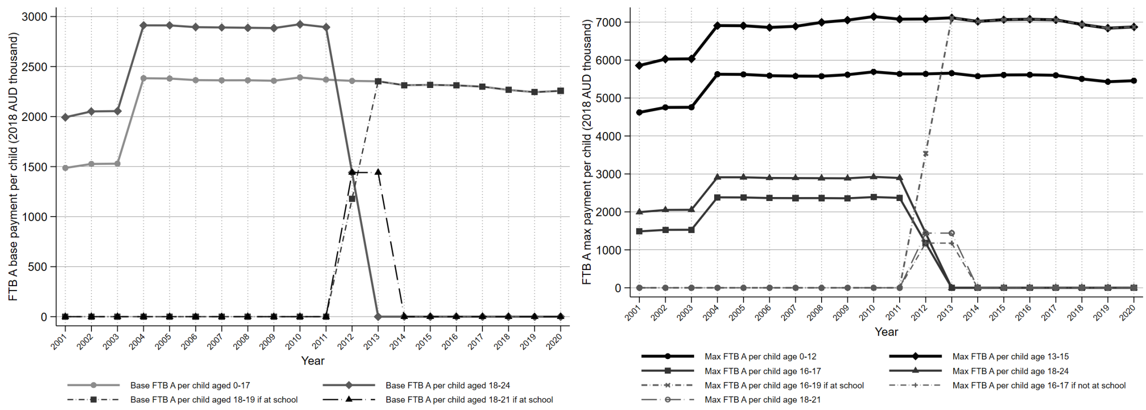

Figure 3: **Base and maximum FTB-A payment rates per qualified child**

At the intensive margin, the FTB-A alone represents a significant sum of inflation-indexed transfer. Despite the intricacy, both panels of Figure 3 illustrate that there have not been much change to the base and maximum statutory payment rates for children under 18. Since 2004, qualified families with a child aged 13-15 could receive up to $7,000, and while the maximum rate for a 12-year-old or younger child is lower, the amount claimable is still over $5,500. Given that payment is allocated

[4]Household wealth is defined as its net worth where net worth is total assets net of total debts. Total assets contain the following components: (i) financial assets (e.g., own and joint bank accounts, children's bank accounts, superannuation, cash investments, equity investments, trust funds, and life insurance), and non-financial assets (e.g., property assets, home asset, other property assets, business assets, collectibles, and vehicles). Total debts comprise credit card debt, joint credit cards, own credit cards, student debt (HECS), other personal debt, business debt, property debt, home debt, other property debt, and overdue household and bills.

per child, the average two-children family could be paid up to $\$14,000$. Moreover, Figure A.3 in the Appendix shows that the benefit delivered to eligible families has been rising. The average FTB-A payout increased from $\$8,000$ to $\$8,500$ (2018 AUD) over the past decade. Additionally, because the scheme targets single-earner families, especially single parents, single parent households claimed higher benefit on average compared to couple parent households (Figure A.4).

The FTB-B

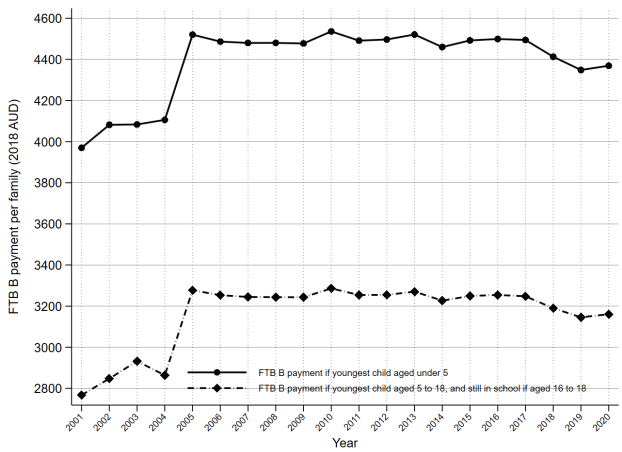

Figure 4: **FTB-B payment rates per family by age of the youngest child in the family**

The FTB-B gives extra support to single parents and single-earner couple parents. Figure A.3 in the Appendix and Figure 5 suggest that the majority of FTB-A households also claimed the FTB-B. While the FTB-A is the largest of the two, the FTB-B offers a non-trivial sum. Figure 4 shows that the FTB-B payment remained steady at approximately $\$4,500$ (2018 AUD) for eligible families whose youngest child is under 5 years of age, and $\$3,200$ if their youngest child is between 5 and 18 years old.

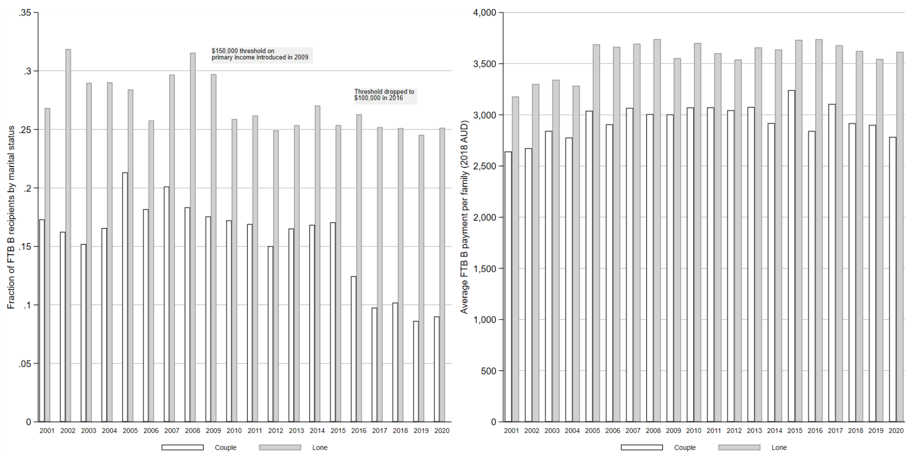

Figure 5: **Fractions of FTB-B recipients and average FTB-B payment per family by marital status.**

Compared to the 2000s and the first half of 2010s, the fraction of partnered FTB-B households plummeted by nearly 50% by 2018 (left panel Figure 5). Similar to the FTB-A, factors such as fertility trend and threshold-creep could partially explain the decline. For the FTB-B in particular, the recent drop in couple recipients could also be attributed to the $150,000 (current AUD) income-test threshold for primary earners introduced in 2009, and the subsequent tightening in 2016 as the threshold decreased further to $100,000. This stricter measure complemented the existing test on secondary earners and reduced the claimant pool. However, because the primary earner's income test exclusively determines eligibility (i.e., controlling the extensive margin), we see no discernible effect on the payment rate. The right panel of Figure 5 shows that eligible single parents in 2020 could still expect to receive over $3,500 in 2018 AUD while couple parents could expect slightly under $3,000 — similar to the amount they would receive from 2005.

The CCS

In the 2018-19 financial year, out of the 1,131,177 families recorded using child care, a substantial 75 with family earnings below $171,958—comprising 96.9of the single-parent families and 70.1 of the couple-parent families—were eligible for at least 50% statutory subsidy rate.[5] The stratification of the effective subsidy rates further underscores the program's broad impact: approximately 32% of the families received an actual subsidy rate between 75-95%, 43% received between 50-75%, 18% received a rate under 50%, with a small remainder receiving no subsidy at all.[6] The pattern suggests the CCS program delivers benefits to the majority of child care users.

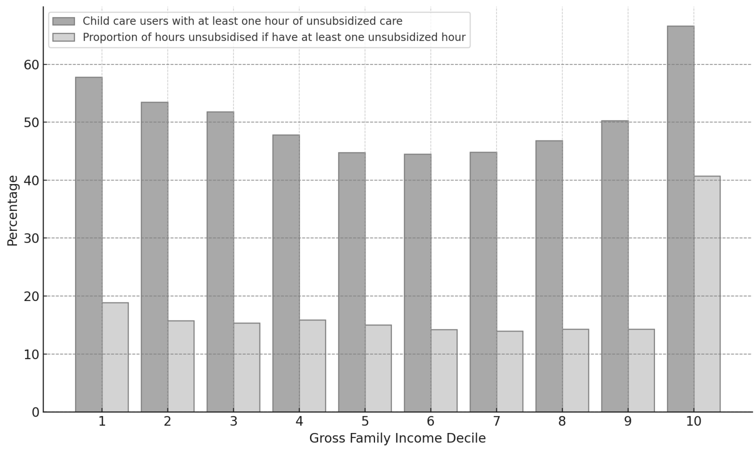

Figure 6: **Proportion of hours paid for that are unsubsidized by gross family income decile in 2018-19 financial year**
Source: The lowest decile earned at most $31,399. The top decile earned $240,818 or more. Data is based on Table 31 of the Child Care Package Evaluation: Final Report, 2021..

Figure 6 portrays the proportion of unsubsidized child care hours and illustrates the program's expansive coverage. Excluding the top decile, a significant majority of families received fully subsidized child care. Case in point, between 50-55 of families situated around the median income received full subsidy. The prevalence of those with at least one hour of unsubsidized child care increases for families in the lower deciles likely due to the work activity requirement, yet approximately 40% of the bottom-decile families enjoyed full subsidy. Additionally, even among families with at least one unsubsidized child care hour, provided that they were not in the top income range (i.e., annual earnings above $240,818), the average unsubsidized hours did not exceed 20% of their total child care hours.

[5]Table 25 and 26, Child Care Package Evaluation: Final Report, 2021..
[6]Figure 34, Child Care Package Evaluation: Final Report, 2021..

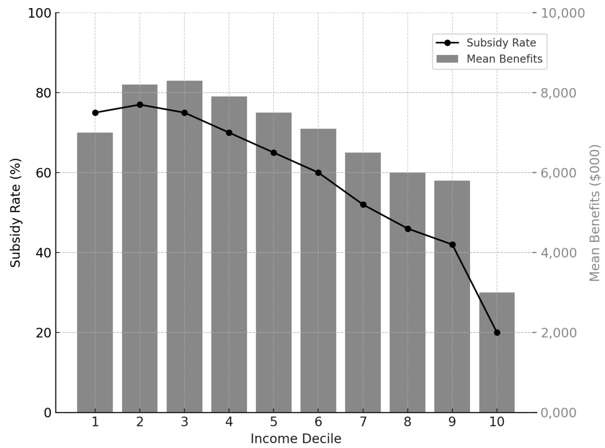

Figure 7: **Child Care Subsidy rates and Mean Benefits (Subsidies) by income decile**
Source: The lowest decile earned at most $\$31,399$. The top decile earned $\$240,818$ or more. Data is based on Table 61 of the Child Care Package Evaluation: Final Report, 2021..

The above examination of the program's reach (extensive margin) suggests that a substantial proportion of families across a broad range of income benefited from the CCS, but one might suspect that high-income families received significantly smaller benefits than their lower-income counterparts since the statutory subsidy rate declines with income. However, the distribution of the average benefits (intensive margin) from Figure 7 suggests otherwise. It demonstrates the significance of the CCS benefits (in absolute magnitude) for its recipients at all levels of income. The average annual benefits were well above $\$7,000$ for those at or below the median income, and for the lowest decile—those earned less than $\$31,399$—in particular, the benefits accounted for at least 20% of their gross earnings. In the same figure, we observe that the (effective) subsidy rate exhibits a progressive trend, decreasing as income increases, yet even higher-income families received notable benefits. For example, omitting the top income, the upper income families still received approximately $\$6,000$. This high benefit disbursement to better-off families could be due to (i) the generous income-test thresholds with a cut-out point above $\$350,000$ (higher than the minimum family income $240,818 of the tenth decile), and (ii) the activity test aimed at fostering workforce participation. In other words, families with higher income do receive a smaller hourly subsidy rate, but conditional on having passed the income test, they can receive substantial subsidies if the secondary earner works full-time.[7] For the same reason, the bottom-decile families might have received lower average benefit than their peers in the adjacent deciles because they worked fewer hours.

2.2 Empirical life cycle facts

Fact 1: Child-related transfers are important income sources. As described in the preceding subsection, the average FTB payments have remained largely unchanged over the past two decades. Accompanying this fact is Figure A.8 which shows hump-shaped life cycle profiles of average FTB payment as a share of gross total income: it peaks during the child-bearing and rearing years and is

[7] According to the Child Care Package Evaluation: Final Report, 2021., families with an income in excess of $186,958 face an annual cap of $\$10,190$ on the CCS per child. However, based on Table 28 in the report, only 1.7% of couple parents and 0.1% of single parents are estimated to have been affected by the cap. Among the affected couple parents, the vast majority are dual-earner families living in a capital city. Table 29 further shows that even when we consider the subset with income between $186,958 (cap threshold) and $351,247 (cut-out point of CCS), only 8.7% are impacted by the annual fee cap.

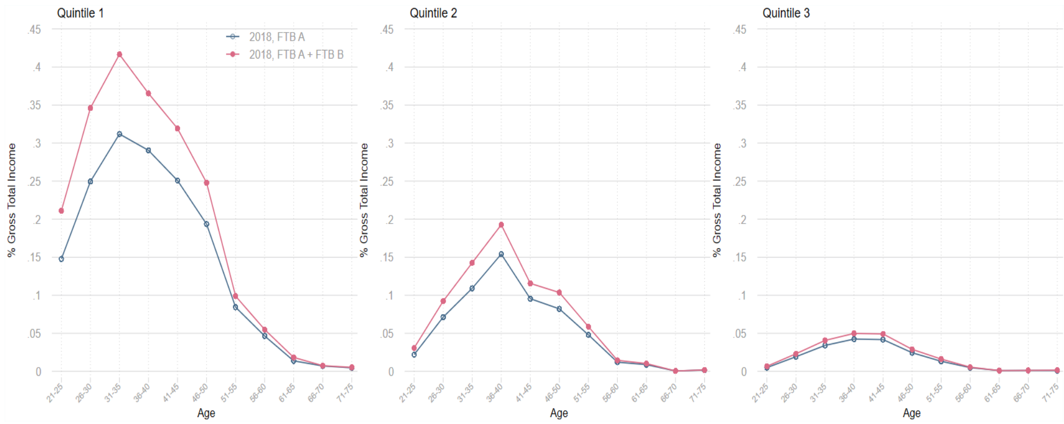

Figure 8: **Age profiles of FTB share of gross household income for the first three quintiles by family market income in 2018**

most significant for the bottom two quintiles. In fact, for the first and second quintile recipients in their late 20s to early 40s, the FTB benefit comprises approximately one-third and one-fifth of their gross total income, respectively. For the poorest household in particular, the FTB at its peak makes up over 40% of their total income.

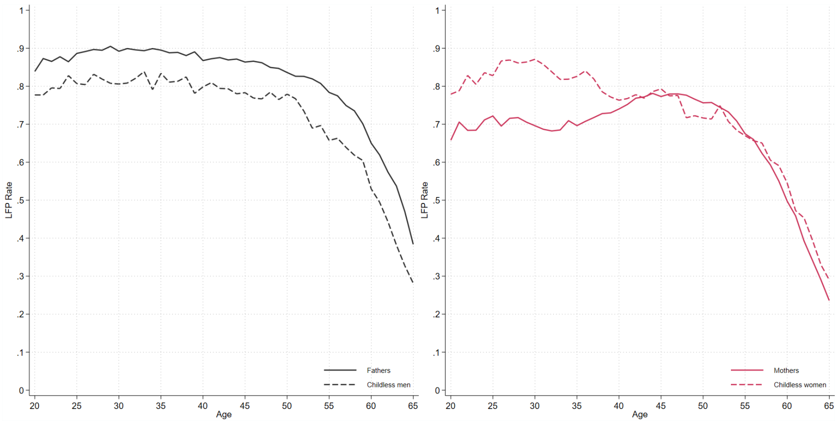

Figure 9: **Age profiles of labor force participation by key demographics (gender and parenthood). Left:** fathers (solid) and childless men (dashed). **Right:** mothers (solid) and childless women (dashed).
Notes: The age profiles stitch together 20-year snapshots of life cycle for selected cohorts. The youngest cohort is cohort 12 aged 20-39 in the data, and the oldest cohort is cohort 12 aged 75-94.

Fact 2: Distinct age-profiles of labor supply of mothers. The presence of dependent children is correlated with different life cycle profiles of labor force participation and full-time share of employment for both men and women.[8] As shown in Figure 9, a larger proportion of fathers participate in the workforce relative to their childless counterparts, a persistent trend throughout their life cycle. The puzzle lies with the case of women. For the first 20 years of their adult lives, a smaller fraction of mothers participate in the workforce compared to childless women. In other words, until the age 35, only 70% of young mothers are in the labor force, whereas the proportion of childless women in the

[8]For our purpose, a 'parent' is defined as an individual with at least one dependent child. This is in order to match with the definition of parenthood in the model. An alternative definition, considering parents as those who have had at least one child regardless of the child's dependency or co-residence status (as in Figure C.3), makes the labor force participation gap between fathers and non-fathers negligible and that between mothers and non-mothers even more apparent.

labor force is around 80% at the onset and peaks above 85% around age 30. This creates a 10*pp* disparity in participation between the two groups, widening in their early 30s and narrowing when both groups reach their early 40s as their profiles merge and follow virtually the same path thereon.

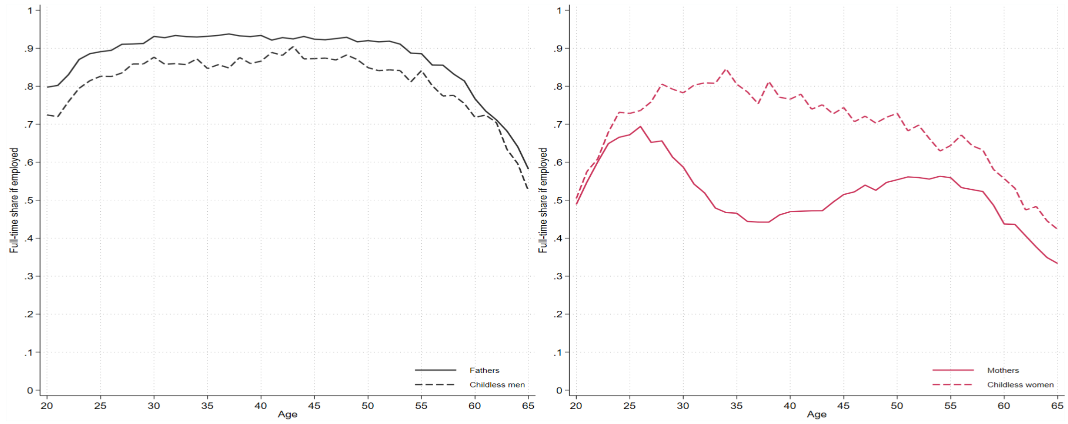

Figure 10: **Age profiles of full-time share of employment by key demographics (gender and parenthood). Left:** fathers (solid) and childless men (dashed). **Right:** mothers (solid) and childless women (dashed).

Figure 10 shows that the life cycle profiles of full-time share of employment exhibit similar patterns. The full-time share profiles of fathers and non-fathers mirror their labor force participation profiles. The divergence between mothers' and non-mothers' profiles is present and even more pronounced. Note that, although the full-time share profile of childless women remain below that of childless men, they both follow a hump-shaped trajectory. The profile of mothers, on the contrary, sketches a distinct M-shaped pattern. The largest divergence between mothers and non-mothers is between age 35-40. During this period, close to 80% of working non-mothers have full-time jobs, contrasting sharply with just 45% of working mothers. While the disparity narrows with age, it never completely closes. There is a gradual recovery but the proportion of working mothers in full-time employment never reaches 60% and the gap between mothers and non-mothers remains at approximately 10*pp* by age 65. Given the relatively stable workforce participation profile of mothers, the recession that creates the distinct M-shaped full-time share profile must be driven largely by the full-time mothers moving to part-time employment. This is further corroborated by the similar evolution of parent and non-parent life cycle profiles of work hours from Figure C.1 in the Appendix. Overall, in contrast to childless women averaging 35-40 work hours per week for much of their working lives, mothers seldom exceed a 35 hour average.

Fact 3: Large earnings discrepancies between mothers and non-mothers. Figure 11 reports the age-profiles of weekly earnings relative to the average earnings of a 21-year-old worker. Non-parents display comparable trajectories over their life cycles. Regardless of gender, their age profiles of earnings have higher peaks and exhibit flatter tails than those of parents. Childless women do tend to earn less than their male peers, especially in the midst of their working lives, but the greatest difference is between mothers and all other non-mother groups. Considering their smaller labor force participation, reduced full-time share of employment, and limited work hours during their prime working years, it is perhaps not surprising that by age 45, mothers' average weekly earnings

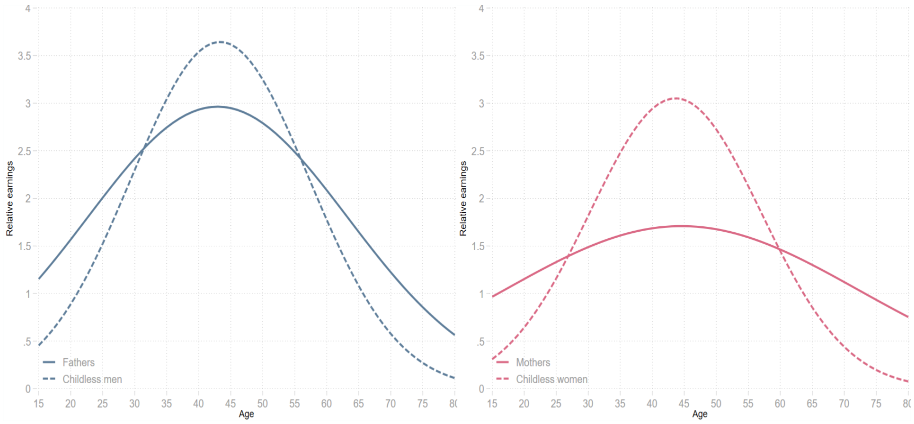

Figure 11: **Age profiles of normalized weekly earnings (against age-21 worker's average earnings) by key demographics (gender and parenthood). Left:** fathers (solid) and childless men (dashed). **Right:** mothers (solid) and childless women (dashed).
Notes: Due to the lack of balanced panel data covering the entire lifespan of individuals, the estimated wages are obtained via a regression of log weekly earnings on quadratic age terms, gender, parenthood, and interactions between the selected demographics and age.

amount to only half of what non-mothers of the same age earn.[9]

3 A simple partial equilibrium model

In this section, we formulate a simple theoretical model to highlight how the inclusion of work subsidy and means-tested transfers, the central features of the child-related programs, can affect a woman's labor supply, her household consumption, and the economic efficiency and welfare.

We consider a representative couple-parent household making a static decision on joint consumption (c) and female labor supply (n^f). The husband's labor supply (n^m) is perfectly inelastic. Labor is awarded at a unit wage rate. Both spouses pay a flat tax rate of τ. To simulate the Child Care Subsidy (CCS) which subsidizes the secondary earner, we further assume that the wife receives a work subsidy of s . We also model a means-tested transfer to simulate the Family Tax Benefit (FTB) that tests family income $n^m + n^f$, has the maximum payout of $\bar{tr}$, income-test threshold $\bar{y}$, and taper rate ω. The household problem is

$$\max_{c,\, n^f} \quad \{u(c, 1 - n^f)\} \tag{1}$$

$$s.t.$$

$$c \;=\; (1-\tau)(n^m + n^f) + \overbrace{sn^f}^{CCS} + \overbrace{MAX\{MIN\{\bar{tr},\ \bar{tr} - \omega(n^m + n^f - \bar{y})\},\ 0\}}^{FTB} \tag{2}$$

Let $u(c, 1 - n^f)$ denote a well-behaved utility function of consumption c and female leisure $1 - n^f$ such that the following properties $u' > 0,\ u'' < 0,\ lim_{x \to 0} u' = \infty,\ \lim_{x\to\infty} u' = 0$ hold true for all its

[9]Figure C.4 in the Appendix confirms that the depressed earnings profile of mothers observed here is independent of marital status.

argument $x \in \{c, 1-n^f\}$. The subsidy, CCS, is proportional to n^f. The simplified FTB is a single-tier means-tested benefit, whose schedule is illustrated in Figure 12.

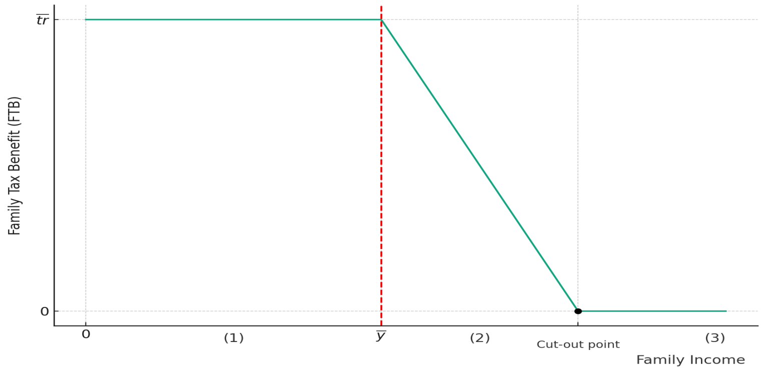

Figure 12: A hypothetical means-tested family tax benefit (FTB) schedule
Note: The slope of the benefit schedule between $\bar{y}$ and the cut-out point is the taper rate, ω.

The FTB creates non-linearity in the budget constraint. Below, we consider the three cases corresponding to zone (1), (2) and (3) of family income in Figure 12 and the implications on the household's budget constraint and marginal rate of substitution of consumption for leisure ($MRS_{c,1-n^f}$).[10]

Case (1). $n^m + n^f \leq \bar{y}$: Family income is less than the threshold $\bar{y}$ and the household receives the maximum transfer $\bar{tr}$

$$\begin{aligned} c &= (1-\tau)(n^m + n^f) + sn^f + \bar{tr} \\ MRS_{c,1-n^f} = \frac{u'_c}{u'_{1-n^f}} &= \frac{1}{(1-\tau+s)} \end{aligned}$$

Case (2). $n^m + n^f > \bar{y}$ and $\bar{tr} - \omega(n^m + n^f - \bar{y}) > 0$: Family income is in the phase-out zone and the household receives a partial transfer $\bar{tr} - \omega(n^m + n^f - \bar{y})$

$$\begin{aligned} c &= (1-\tau)(n^m + n^f) + sn^f + \bar{tr} - \omega(n^m + n^f - \bar{y}) \\ MRS_{c,1-n^f} = \frac{u'_c}{u'_{1-n^f}} &= \frac{1}{(1-\tau-\omega+s)} \end{aligned}$$

Case (3). $n^m + n^f > \bar{y}$and $\bar{tr} - \omega(n^m + n^f - \bar{y}) \leq 0$: Family income is above the cut-out point and the household receives no transfer

$$\begin{aligned} c &= (1-\tau)(n^m + n^f) + sn^f \\ MRS_{c,1-n^f} = \frac{u'_c}{u'_{1-n^f}} &= \frac{1}{(1-\tau+s)} \end{aligned}$$

There are some notable observations. First, the household's budget constraint and $MRS_{c,1-n^f}$ vary based on the family income $(n^m + n^f)$. This suggests that the transfers affect the household's labor decision through two channels: (i) the income effect (IE) via the budget constraint, and (ii)

[10]We abstract from considering its kink at $\bar{y}$ and the cut-out point which creates non-linearity in the household's budget constraint. Depending on the budget constraint and household's preference, the kink might lead to a high density of households having income just below $\bar{y}$ to maintain eligibility for maximum transfer $\bar{tr}$ (i.e., bunching).

income effect and substitution effect (SE) arising from distortion to $MRS_{c,1-n^f}$. The total tax burden $\tau(n^m+n^f)$, subsidy sn^f, and means-tested transfer $\bar{tr}$ in Case (1) and $\bar{tr}-\omega(n^m+n^f-\bar{y})$ in Case (2) are IEs that enter the household budget constraint directly. When the household receives $\bar{tr}$ as in Case (1) or no transfer at all as in Case (3), only τ and s make up the $EMTR$ and distort decision at the margin. With partial means-tested transfer in Case (2), the taper rate ω adds to the $EMTR$ and behaves as a tax on the joint family income above $\bar{y}$ which can be expressed as $\omega(n^m+n^f)$.

Second, if the household's income falls in the FTB's phase-out zone, the $EMTR=\tau+\omega-s$. Therefore, depending the strength of the taper rate ω, it can partially or completely offset the work incentive effect of the subsidy s.

Third, the policy parameter $\bar{tr}$, $\bar{y}$ and ω, and the husband's income n^m can affect the wife's incentive to work. The household will receive benefit if $\bar{tr}-\omega\left(n^m+n^f-\bar{y}\right)>0$. This condition can be re-written as $n^f<\frac{\bar{tr}}{\omega}+\bar{y}-n^m$ which is the upper bound of the wife's income zone over which the FTB applies. The term $\frac{\bar{tr}}{\omega}+\bar{y}$ determines the statutory cutout point of the benefit. All else constant, either raising the payment rate $\bar{tr}$, lowering the taper rate ω, or raising the test threshold $\bar{y}$ expands the coverage of the FTB. Moreover, because the transfer tests joint income, the effective cutout point is affected by the male labor income n^m. In other words, if n^m is sufficiently large, the family income may already be in the phase-out zone as in Case (2) or out of the FTB eligibility zone entirely as in Case (3). The former implies the wife's labor decision at the margin will face a higher $EMTR$ due to the taper rate ω, whereas the latter implies the FTB is not relevant for her decision. In contrast, if n^m is such that $n^m+n^f<\bar{y}$ as in Case (1), then n^f at the margin is not affected by ω, but it is still affected by the positive IE associated with $\bar{tr}$.

The discussion above is concerned primarily with the general characteristics of child-related transfers and how they can influence the representative household's decision making. To see more clearly the efficiency and welfare impacts, consider Case (2) and suppose the household's preference is represented by a Cobb-Douglas utility $u(c,1-n^f)=c^{\alpha}(1-n^f)^{1-\alpha}$ where α is the taste-for-consumption parameter. The associated first-order conditions and budget constraint give us the following expressions for n^f and $ln(u)$.

$$n^f = \alpha - \underbrace{\frac{1-\alpha}{1-EMTR}}_{(a)\text{ price distortion}}\left[\underbrace{(1-\tau)n^m+FTB}_{(b)\text{ direct positive IE}}\right] \tag{3}$$

$$\begin{aligned} ln(u) &= \alpha ln(\alpha)+(1-\alpha)ln(1-\alpha)-\overbrace{(1-\alpha)ln(1-EMTR)}^{(c)\text{ price distortion on leisure}} \\ &\quad + ln\left[\underbrace{(1-EMTR)}_{\text{(d) price distortion}}+\underbrace{(1-\tau)n^m+FTB}_{(e)\text{ direct positive IE}}\right] \end{aligned} \tag{4}$$

where $EMTR=\tau+\omega-s$ and $FTB=\bar{tr}-\omega(n^m+n^f-\bar{y})$. We define welfare as the utility $u:=u(c,1-n^f)$ and use n^f as the proxy for efficiency. We observe two channels that affect efficiency and welfare. The first channel is the direct positive IE—the male net income $(1-\tau)n^m$ and the transfer FTB—appearing as term (b) that reduces n^f in Equation 3 and term (e) that raises $ln(u)$ in Equation 4. The second channel is associated with the price distortion by the $EMTR$ which is term (a) in in Equation 3, and term (c) and (e) in Equation 4. With regards to efficiency, the $EMTR$

is a negative effect on efficiency. However, its effect on welfare is ambiguous. On the one hand, its SE is such that household substitutes away from consumption and towards leisure. As a result, for $0 < EMTR < 1$, a higher $EMTR$ in term (c) contributes positively to welfare, and its magnitude is weighted by the household's taste for leisure $(1 - \alpha)$. On the other hand, the $EMTR$'s negative IE shows up as term (d). Because it reduces the household's consumption and leisure, a higher $EMTR$ reduces welfare.

This simple theoretical exercise highlights potential channels through which child-related transfers may influence household decisions, efficiency, and welfare. It also demonstrates the significance of the transfer financing mechanism (i.e., tax burden τ). Because τ is a part of the price distortion and the direct IE in Equation 3 and 4, a high τ could partially or completely offset the intended efficiency and/or welfare effects of child-related transfers. This warrants a quantitative exploration in a General Equilibrium (GE) environment with τ as the endogenous policy parameter to maintain the public budget balance. Furthermore, the benefits and tax burden vary across the socioeconomic and demographic landscape. For instance, the benefit concentrates within the population of parents with dependent children, whereas non-parents and working seniors receive no benefit and bear the tax burden. Hence, this calls for a Heterogeneous-Agent framework with life cycle feature to fully account for the redistributional implication of the child-related transfer program.

Motivated by the empirical facts and the analytical results above, we build a dynamic general equilibrium overlapping generations model with heterogeneous agents to explore the efficiency, welfare and equity implications of potential child-related transfer reforms. We encapsulate the non-linearities created by the means-tested benefits and consider realistic policy counterfactuals by integrating the actual FTB and CCS plans into our model. The next section describes the quantitative environment.

4 A dynamic general equilibrium 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.

4.1 Demographics

Every period t a new cohort of households aged $j = 1$ (equivalent to the real age of 21) enters the economy. Each adult member of gender $i \in \{m, f\}$ of a household born in time t survives for an entire period $t + j - 1$ with a time-invariant conditional probability $\psi_{j,i}$ and can live to the maximum age $J = 80$ (i.e., $\psi_{J+1,i} = 0$). Individuals start working from $j = 1$ and retire at age $J_R = 45$. The total number of households at time $t = 0$ is normalized to one. The model population grows at a constant rate of n.

Family structure. There are three types of family assigned at birth to households in the model economy: (i) married couple with children ($\lambda = 0$), (ii) single childless men ($\lambda = 1$) and (iii) single mothers ($\lambda = 2$). Married households comprise a husband and a wife of identical age and education. Marital status over the life cycle depends solely on survival probabilities. More precisely, a married household will become single if one of the spouses dies. Single households remain single till death.

There are no divorce, marriage, or re-marriage. The transition probabilities for family structure ($\pi_{\lambda_{j+1}|\lambda_j}$) is given by

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

Table 1: 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. They neither contribute to the utility of their parents nor the broader economy when they reach adulthood. Households possess full information on the arrival time of children, the non-pecuniary and pecuniary child care costs, 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 uniform for all households. There is no informal care. Households 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 education. The firstborn arrives earlier for low-education (θ_L) households and later for high-education (θ_H) households. 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 $nc_{j,\theta} = \sum_{k=1}^{\bar{nc}} \mathbf{1}_{\{b_{k,\theta}\ \leq\ j\ \leq\ b_{k,\theta}+17\}}$.[11]

4.2 Preferences

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

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

where c is the joint consumption, l^m is the leisure time of male, l^f is the leisure time of female, λ is the household type, θ is the education level, and β is the time discount factor. We suppress the age subscript j to ease notation. The periodic household utility function for each household type can be written as follows

[11] Note that, we assume children and population growth are detached. Children and child care are exogenous and deterministic life event for all couples and single mothers. Parents derive no utility from having children in the current context where fertility is exogenous. Making children affect the household utility, aside from the indirect effect through time cost on leisure, is not a necessary feature. The resources allocated to the child upbringing also do not contribute to the future labor force productivity.

$$
\begin{aligned}
u(c, l^m, l^f, \theta, \lambda = 0) &= \frac{\left[\left(\frac{c}{ces_{0,\theta}}\right)^{\nu} (l^m)^{1-\nu}\right]^{1-\frac{1}{\gamma}} + \left[\left(\frac{c}{ces_{0,\theta}}\right)^{\nu} (l^f)^{1-\nu}\right]^{1-\frac{1}{\gamma}}}{1-\frac{1}{\gamma}}, \\
u(c, l^m, \lambda = 1) &= \frac{\left[(c)^{\nu} (l^m)^{1-\nu}\right]^{1-\frac{1}{\gamma}}}{1-\frac{1}{\gamma}}, \\
u(c, l^f, \theta, \lambda = 2) &= \frac{\left[\left(\frac{c}{ces_{2,\theta}}\right)^{\nu} (l^f)^{1-\nu}\right]^{1-\frac{1}{\gamma}}}{1-\frac{1}{\gamma}},
\end{aligned}
$$

where ν is the taste for consumption, γ is the elasticity of intertemporal substitution (EIS) and $ces_{\lambda,\theta} = \sqrt{\mathbf{1}_{\{\lambda \neq 1\}} + \mathbf{1}_{\{\lambda \neq 2\}} + nc_{\theta}}$ is the consumption equivalence scale.

4.3 Endowments

Married and single men. Men always work full-time until retirement and earn labor income $y^m_{j,\lambda} = w n^m_{j,\lambda} e^m_{j,\lambda}$ where w is market wages, and $n^m_{j,\lambda}$ and $e^m_{j,\lambda}$ are exogenous labor supply and earning ability, respectively, for men in household type $\lambda \in \{0, 1\}$ at age j. Their intensive margin of labor supply $n^m_{j,\lambda} = 1 - l^m_{j,\lambda}$ is set at the normalized average work hours over working age. The earning ability $e^m_{j,\lambda}$ can be decomposed into a deterministic component $\overline{e}_j$ and a stochastic shock ϵ^m_j

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

where $\overline{e}_j \left(\theta, h^m_{j,\lambda}\right) = e^{\theta} h^m_{j,\lambda}$ is a non-linear function of education level θ and male human capital, $h^m_{j,\lambda}$. The stochastic shock ϵ^m_j is modeled as a first-order auto-regressive process

$$
\overbrace{\ln\left(\epsilon^m_j\right)}^{=\eta^m_j} = \rho \times \overbrace{\ln\left(\epsilon^m_{j-1}\right)}^{=\eta^m_{j-1}} + \upsilon^m_j, \tag{5}
$$

with a persistence parameter ρ and a white-noise disturbance $\upsilon^m_j \sim N\left(0, \sigma^2_{\upsilon}\right)$.

Married and single women. In addition to the joint consumption/savings 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, a woman's labor choice is concerned with whether to exit the labor force ($\ell = 0$), work part time ($\ell = 1$), or full time ($\ell = 2$). If she participates in the labor force, she will commit to an exogenous work hour plan $n^f_{j,\lambda,\ell}$ that varies by her age, family and employment types. This decision is influenced by the act of balancing work-related trade-offs to achieve the household utility maximization objective. These trade-offs, as described below, affect female labor supply behavior, their susceptibility to the insurance and incentive effects of the transfer schemes, and ultimately, how they respond to reforms in the counterfactual economies.[12]

[12] The defining features of trade-offs are parameters associated with the costs and benefits of work for women, and not limited to the FTB and the CCS parameters. Examples are education level and human capital accumulation rate. High-education women have a higher return to labor and are less likely to respond to an increase in the FTB transfer. A high rate of human capital accumulation allows for a faster wage growth should a woman choose to work over multiple periods

The benefits of work. If a woman works, she (i) *earns labor income* ($y^f_{j,\lambda} = wn^f_{j,\lambda,\ell}e^f_{j,\lambda}$), (ii) *accumulates human capital for the next period* ($h^f_{j+1,\lambda}$), and (iii) *obtains child care subsidy of sr_j per child* if she meets the CCS eligibility criteria as laid out in section 5.5. Her earning ability is

$$e^f_{j,h} = \overline{e}_j\left(\theta, h^f_{j,\lambda,\ell}\right) \times \epsilon^f_j,$$

where $\overline{e}_j\left(\theta, h^f_{j,\lambda,\ell}\right)$ is determined by her education θ and the human capital $h^f_{j,\lambda,\ell}$. As her male counterparts, the stochastic component ϵ^f_j is governed by an auto-regressive process so that $\ln\left(\epsilon^f_j\right) = \rho \times \ln\left(\epsilon^f_{j-1}\right) + \upsilon^f_j$, with persistence parameter ρ and a white-noise disturbance $\upsilon^f_j \sim N\left(0, \sigma^2_\upsilon\right)$.

Different from the male earning ability, however, the female earning ability $e^f_{j,\lambda}$ contains an endogenously evolving human capital component over life cycle according to the law of motion

$$log(h^f_{j,\lambda,\ell}) = log(h^f_{j-1,\lambda,\ell}) + (\xi_{1,\lambda,\ell} - \xi_{2,\lambda,\ell} \times (j-1))\,\mathbf{1_{\{\ell_{j-1}\neq 0\}}} - \delta_l(1 - \mathbf{1_{\{\ell_{j-1}\neq 0\}}}), \tag{6}$$

where the human capital from working, i.e., $\ell \neq 0$, is gained at a diminishing rate over age j and is determined by the coefficient $\xi_{1,\lambda,\ell} - \xi_{2,\lambda,\ell} \times (j-1)$. δ_ℓ is the depreciation rate of human capital when not working, i.e., $\ell = 0$.[13]

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-testing FTB transfers*, and (iii) *sacrifices leisure on top of incurring a fixed time cost χ_p if she works part-time and χ_f if she works full-time.* With regards to the time cost (iii), we can say more precisely that at age j, her labor choice (ℓ) and family type (λ) affects her leisure time l^f_j in the following sense

$$l^f_{j,\lambda} = \begin{cases} 1 & \text{if stay at home } (\ell = 0) \\ 0 < 1 - n^f_{j,\lambda,\ell=1} - \chi_p < 1 & \text{if work part time } (\ell = 1) \\ 0 < 1 - n^f_{j,\lambda,\ell=2} - \chi_f < 1 & \text{if work full time } (\ell = 2). \end{cases} \tag{7}$$

where χ_p and χ_f are the fixed leisure costs associated with full-time and part-time work, respectively (with or without children).[14]

The female labor supply decision therefore hinges on the costs and benefits of work which are influenced by the time cost of work, the cost of formal child care service, and the consumption insurance and work incentive effects of the family and child support schemes, namely the FTB and the CCS. There are also other factors related to return to labor such as her human capital potential and earnings shocks, and the presence of family insurance (i.e., her partner's labor earnings) that will be discussed in more detail in our main quantitative analysis in section 7.

[13]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 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 returns to productive time in the data since we do not actually observe them in reality.

[14]We assume the time cost is a penalty on the wife's leisure in a perfectly altruistic household. Evidence from multiple sources, including an ABS report on barriers and incentives to labor force participation, suggests child care responsibilities are more heavily weighted on mothers.

4.4 Technology

There is a representative firm with labor-augmenting technology A and a Cobb-Douglas production function that transforms capital K and total 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 rate g_t and K_t depreciates at a rate δ_t. The firm pays capital income tax τ_t^k, and chooses capital and labor inputs to maximize its profit, taking as given the rental rate $q_t = r_t + \delta_t$ and the wage rate w_t according to

$$\max_{K_t, L_t} \quad (1-\tau_t^k)(Y_t - w_t A_t L_t) - q_t K_t, \tag{8}$$

The firm's first-order conditions are:

$$r_t = (1-\tau_t^k)\alpha\frac{Y_t}{K_t} - \delta_t, \tag{9}$$

$$w_t = (1-\alpha)\frac{Y_t}{A_t L_t} \tag{10}$$

4.5 Fiscal policy

We model key features of the Australian fiscal system including an income tax system, two means-tested transfer programs for families with children, and a means-tested pension program for retirees.

Progressive income tax. The government levies tax on individual labor and capital earnings via a progressive income tax schedule.[15] Having a progressive tax mechanism in the model makes it possible to capture the extra distortions (or, lack thereof) when tax interacts with the child-related transfers at different pre-government income levels. For instance, in a tax-free or low-tax earnings zone of a progressive scheme, the FTB taper rate's effects could be less consequential compared to its effects under a proportional scheme.

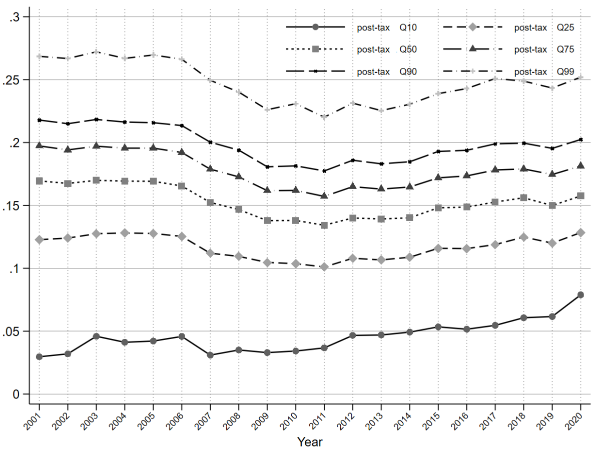

Figure 13: **Estimates of average taxes by quantiles over time using the parametric tax function 11.**
Notes: To obtain the estimates, normalize $\tilde{y}$ in the equation 11 by y_Q which corresponds to income at the Q^{th} quantile of the pre-government income distribution. When $\tilde{y} = y_Q$, it is easy to show that $(1-\zeta)$ is the tax liability for the Q^{th} quantile. For further explanation, see the Appendix's subsection A.4.

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

The taxable income for an individual $i \in \{m, f\}$ at age j is $\widetilde{y}^i_{j,\lambda}$ which comprises labor income $y^i_{j,\lambda}$, and capital income ra_j if single or a half of joint 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 approximate the tax schedule using a parametric tax function following Feldstein 1969; Benabou 2000; Heathcote, Storesletten and Violante 2017. Suppressing the family type λ subscript and gender i superscript, the individual income tax payment is given by

$$tax_j = \max\left\{0, \widetilde{y}_j - \zeta \widetilde{y}_j^{1-\tau}\right\}, \tag{11}$$

where tax_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_j approaches $\tilde{y}_j$ implying 100% of the taxable income is taxed. On the other extreme end, if $\tau = 0$, then $tax_j = (1-\zeta)\tilde{y}_j$ and thus $(1-\zeta)$ is a flat tax rate. We impose a non-negative tax restriction, $tax_j \geq 0$, to exclude all government transfers in the form of negative income tax.

The government runs means-tested transfer schemes to support eligible parents with children. There are two main programs: Family Tax Benefit (part A and part B) and Child Care Subsidy. 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_j^{A1} and tr_j^{A2}, (ii) joint 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_j^A, received by a household is given by

$$tr_j^A = \begin{cases} tr_j^{\mathrm{A1}} & \text{if } y_{j,\lambda} \leq \bar{y}^{tr}_{max} \\ \max\left\{tr_j^{\mathrm{A2}},\ tr_j^{\mathrm{A1}} - \omega_{A1}\left(y_{j,\lambda} - \bar{y}^{tr}_{max}\right)\right\} & \text{if } \bar{y}^{tr}_{max} < y_{j,\lambda} \leq \bar{y}^{tr}_{base} \\ \max\left\{0,\ tr_j^{\mathrm{A2}} - \omega_{A2}\left(y_{j,\lambda} - \bar{y}^{tr}_{base}\right)\right\} & \text{if } y_{j,\lambda} > \bar{y}^{tr}_{base}, \end{cases} \tag{12}$$

where $y_{j,\lambda} = \mathbf{1}_{\{\lambda \neq 2\}} y^m_{j,\lambda} + \mathbf{1}_{\{\lambda \neq 1, \ell \neq 0\}} y^f_{j,\lambda} + ra_j$ 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 determined by marital status and separate tests on primary earner's and secondary earner's taxable income. Important policy 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_j^{B1} and tr_j^{B2}; (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 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_j^B, is then given by

$$
tr^B_j = \begin{cases} \Upsilon_1 \times tr^{\mathrm{B1}}_j + \Upsilon_2 \times tr^{\mathrm{B2}}_j & \text{if } y_{pe} \leq \bar{y}^{tr}_{pe} \text{and } y_{se} \leq \bar{y}^{tr}_{se} \\ \\ \Upsilon_1 \times \max\left\{0,\ tr^{\mathrm{B1}}_j - \omega_B(y_{se} - \bar{y}^{tr}_{se})\right\} & \text{if } y_{pe} \leq \bar{y}^{tr}_{pe} \text{and } y_{se} > \bar{y}^{tr}_{se} \\ +\Upsilon_2 \times \max\left\{0,\ tr^{\mathrm{B2}}_j - \omega_B(y_{se} - \bar{y}^{tr}_{se})\right\} \end{cases} \tag{13}
$$

where $\Upsilon_1 = \mathbf{1}_{\{nc_{[0,4],j} \geq 1\}}$ and $\Upsilon_2 = \mathbf{1}_{\{nc_{[0,4],j}=0\, and\, nc_{[5,18],j} \geq 1\}}$ are indicator variables, $nc_{[a,b],j}$ is the number of dependent children in the age range $[a, b]$ for households aged j.

Child care subsidy (CCS). The government also runs a child care subsidy program (CCS) to support the cost of formal child care for children aged 13 or younger. The CCS payment has a joint household income test, and is dependent on the age and number of dependent children. In addition, the CCS is conditional on work.[16] Key parameters determining eligibility and rate of subsidy per child include (i) joint 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., $\{\omega^1_c, \omega^3_c\}$. The CCS rate per child, sr, at age j is given by

$$
sr_j = \Psi(y_{j,\lambda}, n^m_{j,\lambda}, n^f_{j,\lambda,\ell}) \times \begin{cases} sr_1 & \text{if } y_{j,\lambda} \leq \bar{y}^{sr}_1 \\ max\{sr_2,\ sr_1 - \omega^1_c\} & \text{if } \bar{y}^{sr}_1 < y_{j,\lambda} < \bar{y}^{sr}_2 \\ sr_2 & \text{if } \bar{y}^{sr}_2 \leq y_{j,\lambda} < \bar{y}^{sr}_3 \\ max\{sr_3,\ sr_2 - \omega^3_c\} & \text{if } \bar{y}^{sr}_3 \leq y_{j,\lambda} < \bar{y}^{sr}_4 \\ sr_3 & \text{if } \bar{y}^{sr}_4 \leq y_{j,\lambda} < \bar{y}^{sr}_5 \\ sr_4 & \text{if } y_{j,\lambda} \geq \bar{y}^{sr}_5, \end{cases} \tag{14}
$$

where $y_{j,\lambda} = \mathbf{1}_{\{\lambda \neq 2\}} y^m_{j,\lambda} + \mathbf{1}_{\{\lambda \neq 1, \ell \neq 0\}} y^f_{j,\lambda} + ra_j$ is the joint income and ω^i_c is the taper rate. $\Psi(y_{j,\lambda}, n^m_{j,\lambda}, n^f_{j,\lambda,\ell})$ 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 $n^{min}_j = min\{n^m_{j,\lambda}, n^f_{j,\lambda,\ell}\}$ be the household's minimum work hour. The adjustment factor is given by

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

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

Age pension. Age pension is means-tested, using income and assets tests, and independent of the contribution history. The pension is available to households upon having reached the age threshold $j = J_P$. Let $\mathcal{P}^a(a_j)$ be the claimable pension benefit based on the assets test

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

[16] 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.

where p^{max} is the maximum pension payment, $\bar{a}_1^P$ is the assets test threshold and ω_a is its corresponding taper rate. Let $\mathcal{P}^y(y_{j,\lambda})$ be the claimable amount according to the income test

$$\mathcal{P}^y(y_{j,\lambda}) = \begin{cases} p^{\max} & \text{if } y_{j,\lambda} \leq \bar{y}_1^p \\ \max\{0,\ p^{\max} - \omega_y(y_{j,\lambda} - \bar{y}_1^p)\} & \text{if } y_{j,\lambda} > \bar{y}_1^p, \end{cases} \tag{16}$$

where $\bar{y}_1^p$ is the income test threshold and ω_y is the income test taper rate. The amount of pension benefit, pen_j, received by a household is determined by

$$pen_j = \begin{cases} \min\{\mathcal{P}^a(a_j), \mathcal{P}^y(y_{j,\lambda})\} & \text{if } j \geq J_P \text{ and } \lambda = 0 \\ \frac{2}{3}\min\{\mathcal{P}^a(a_j), \mathcal{P}^y(y_{j,\lambda})\} & \text{if } j \geq J_P \text{ and } \lambda = 1,2 \\ 0 & \text{otherwise} \end{cases} \tag{17}$$

Government budget. The government at time t collects taxes on consumption, company profit and household income (T_t^C, T_t^K, T_t^I), and issues bonds $(B_{t+1} - B_t)$ 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 and CCS), Tr_t; and the age pension, $\mathcal{P}_t$. The inter-temporal government budget is given by

$$T_t^C + T_t^K + T_t^I + (B_{t+1} - B_t) \quad = \quad G_t + Tr_t + \mathcal{P}_t + r_t B_t \tag{18}$$

4.6 Market structure

Markets are incomplete. Households cannot insure against idiosyncratic labor income and mortality risks by trading state contingent assets. They can hold one-period risk-free assets to insure against these risks. We assume agents are not allowed to borrow against future income, implying asset holdings are non-negative.[17]

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 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.

4.7 The household problem

Households are heterogeneous in terms of age $j \in \{1, 2, \ldots, J\}$, household type $\lambda \in \Lambda$ where $\Lambda = \{0, 1, 2\}$, education realized at birth $\theta \in \Theta$ where $\Theta = \{\theta_l, \theta_h\}$, female human capital $h_{j,\lambda}^f \in H$ where $H = [h_{min}, h_{max}] \subset \mathcal{R}^+$, asset holdings $a_j \in A$ where $A = [a_{min}, a_{max}] \subset \mathcal{R}^+$ and transitory shocks to male and female labor income, ϵ_j^m and $\epsilon_j^f \in S$ where $S \subset \mathcal{R}$.

[17] Without a borrowing constraint, it would require a low EIS γ (or, high relative risk aversion parameter) for the model to generate a time path of consumption that is not too erratic. In the presence of borrowing constraint, however, young economic agents are prevented from borrowing excessively against their future income, and hence, the constraint allows a realistic consumption path in a model environment with γ within the standard value range of gamma.

Workers. Define $Z = \Lambda \times A \times H \times \Theta \times S \times S$ as the state space for each household aged $j < J_R$.[18] Let $z_j = \left\{\lambda_j, a_j, h^f_{j,\lambda,\ell}, \theta, \eta^m_j, \eta^f_j\right\} \in Z$ be the current period composite state variable and and $z_+ = \{\lambda_{j+1}, a_{j+1}, h^f_{j+1,\lambda,\ell}, \theta, \eta^m_{j+1}, \eta^f_{j+1}\} \in Z$ be the next period composite state. For a given state combination at the beginning of age j, the household decides on joint consumption (c), female participation (ℓ), and next period joint assets (a_+) from a choice set $\mathcal{C} \equiv \{(c, \ell, a_+) \in \mathcal{R}^{++} \times \{0,1,2\} \times \mathcal{R}^+\}$ to maximize its expected lifetime utility according to

$$V(z) = \max_{c,\,\ell,\,a_+} \left\{ u(c, l^m, l^f, \theta, \lambda) + \beta \sum_{\Lambda} \int_{S^2} V(z_+)\, d\Pi(\lambda_+, \eta^m_+, \eta^f_+ | \lambda, \eta^m, \eta^f) \right\} \quad (19)$$

$$s.t.$$

$$\begin{aligned}
(1+\tau^c)c + (a_+ - a) + \mathbf{1}_{\{\lambda\neq 1,\,\ell\neq 0\}} n^f_\lambda \times CE_\theta &= y_\lambda + \mathbf{1}_{\{\lambda\neq 1\}}(nc_\theta \times tr^A + tr^B) + beq - T_\lambda \\
c_j &> 0 \\
a_+ &\geq 0 \\
l^m = 1 - n^m_\lambda \quad &\text{if} \quad \lambda \neq 2 \\
l^f = 1 - \mathbf{1}_{\{\ell\neq 0\}} n^f_{\lambda,\ell} - (\mathbf{1}_{\{\ell=1\}}\chi_p + \mathbf{1}_{\{\ell=2\}}\chi_f) \quad &\text{if} \quad \lambda \neq 1
\end{aligned}$$

We suppress the subscript j wherever appropriate to ease the notation. β is the time discount factor; $y_\lambda = \mathbf{1}_{\{\lambda\neq 2\}} y^m_\lambda + \mathbf{1}_{\{\lambda\neq 1,\,\ell\neq 0\}} y^f_\lambda + ra$ is the total household market income; $CE_\theta = w(1 - sr)\sum_{i=1}^{nc_\theta} \kappa_i$ is the net formal child care expense per hour; tr^A and tr^B are the FTB part A and B transfers; κ_i and sr_i are the hourly child care cost as a fraction of hourly wages and the CCS rate for the i^{th} child, respectively; τ^c is the consumption tax; and $T_\lambda = \mathbf{1}_{\{\lambda\neq 2\}} tax^m + \mathbf{1}_{\{\lambda\neq 1\}} tax^f$ is the household income tax payment where tax^i for $i \in \{m, f\}$ is calculated using the tax function 11. Bequest motives are not operative. Households are born with no wealth ($a_1 = 0$), and each alive working-age household at age j receives a uniform lump-sum transfer of accidental bequest, beq, from deceased households of the same period.

Retirees. Retirement at age J_R is mandatory. The education and transitory shock states becomes absorptive states. In addition, since children are no longer dependent by the time parents have reached their retirement, retirees are not eligible for the child-related transfers. Pension payout is not conditional on earning history but is conditional on household type, λ. An eligible single household receives only two-third of the maximum pension payment that a couple would receive. The state vector of a retired household at age $J_R \leq j \leq J$ is therefore simplified to $z^R = \{\lambda, a\} \in \{0,1,2\} \times \mathcal{R}^+$ and their choice set is $\mathcal{C}^R \equiv \{(c, a_+) \in \mathcal{R}^{++} \times \mathcal{R}^+\}$. Suppressing the j subscript, the retired household optimization problem reduces to

$$V(z^R_j) = \max_{c,\,a_+} \left\{ u(c, \lambda) + \beta \sum_{\Lambda} V(z^R_+)\, d\Pi(\lambda_+ | \lambda) \right\} \quad (20)$$

$$s.t.$$

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

$$
\begin{aligned}
(1+\tau^c)c + (a_+ - a) &= ra + pen - T_\lambda \\
c &> 0 \\
a_+ \geq 0 \quad and &\quad a_{J+1} = 0
\end{aligned}
$$

where pen is the Age Pension described in equation 17.

4.8 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 female human capital ($h^f_{\lambda,j=1} = 0$) 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 and superscripts of the state variables wherever appropriate 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 $\eta^m, \eta^f \in S$.

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

$$
\phi_{t+1}(z_+) = \int_{\Lambda\times A\times H\times\Theta\times S^2} \mathbf{1}_{\{a_+=a_+(z,\Omega_t),\, h_+=h_+(z,\Omega_t)\}} \times \pi(\lambda_+|\lambda) \times \pi(\eta^m_+|\eta^m) \times \pi(\eta^f_+|\eta^f)\, d\Phi_t(z) \quad (21)
$$

where Ω_t is a vector of behavioral, technology and policy parameters at time t, $\pi(\eta^i_+|\eta^i)$ 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 1. Assets and human capital are endogenous states that evolve continuously. The share of households on each of the next period (a^+, h^+) pairs is obtained through linear interpolations of $a_+$and $\log(h_+)$ on the assets (A) and human capital (H) discretized domains, 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. For an economy governed by a vector of parameters Ω_t in time t, the aggregate variables of consumption C_t, 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

[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 is done when aggregating over cohorts.

$$
\begin{aligned}
C_t &= \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} c(z_j,\Omega_t)\mu_{j,t}\, d\Phi_t(z_j) \\
A_t &= \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} a(z_j,\Omega_t)\mu_{j,t}\, d\Phi_t(z_j) \\
LFP_t &= \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} \mathbf{1}_{\{\ell(z_j,\Omega_t)\neq 0\}}\mu_{j,t}\, d\Phi_t(z_j). \\
LM_t &= \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} h^m_{j,\lambda} e^{\theta+\eta^m} n^m_{j,\lambda}\mu_{j,t}\, d\Phi_t(z_j) \\
LF_t &= \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} \mathbf{1}_{\{\ell(z_j,\Omega_t)\neq 0\}} h^f_{j,\lambda,\ell} e^{\theta+\eta^f} n^f_{j,\lambda,\ell}\mu_{j,t}\, d\Phi_t(z_j).
\end{aligned}
$$

The aggregate government variables are

$$
\begin{aligned}
T^C_t &= \tau^c_t C_t \\
T^K_t &= \tau^k_t (Y_t - w_t A_t L_t) \\
T^I_t &= \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} tax_j \mu_{j,t}\, d\Phi_t(z_j). \\
Tr_t &= \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} (FTB_j + CCS_j)\, \mu_{j,t}\, d\Phi_t(z_j) \\
\mathcal{P}_t &= \sum_{j=1}^{J} \int_{\Lambda\times A\times H\times\Theta\times S^2} pen_j \mu_{j,t}\, d\Phi_t(z_j).
\end{aligned}
$$

where tax_j is the calculated using Equation 11, $FTB_j = tr^A_j \times nc_\theta + tr^B_j$ is the sum FTB-A of Equation 12 and FTB-B of Equation 13, $CCS_j = w_t \times sr_j \sum_{i=1}^{nc_{j,\theta}} \kappa_i$ is the total CCS with a subsidy rate sr_j from Equation 14, and $L_t = LM_t + LF_t$ is the total labor supply in efficiency unit.

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 19 and 20;

(b) The firm chooses labor and capital inputs to solve its profit maximization problem 8;

(c) The government periodic budget constraint 18 is satisfied;

(d) The factor markets clear, $K^s_t = K^d_t = K_t$ and $L^s_t = L^d_t = L_t$, where

$$
\begin{aligned}
K^s_t &= A_t - B_{F,t} - B_t \\
L^s_t &= LM_t + LF_t;
\end{aligned}
$$

(e) The goods market clears:

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

where $I_t = (1+n)(1+g)K_{t+1} - (1-\delta)K_t$ is investment. NX_t is the trade account and $NX_t > 0$ denotes a trade account surplus.[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. 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

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

4.9 Efficiency and Welfare

We use per capita output as a proxy for economic efficiency. Therefore, per capita output gain (loss) is equivalent to efficiency gain (loss).

[20] See Appendix 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 is the probability that both spouses survive and the household maintains its status quo marital status.

[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 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, accidental 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.

Ex-ante welfare changes are measured in consumption and leisure terms according to a Hicksian Equivalent Variation (HEV) method. That is, a welfare change for newborns from a policy reform can be expressed as

$$HEV_{newborns} = \left[\left(\frac{V(z_{j=1}, \Omega_{t=1})}{V(z_{j=1}, \Omega_{t=0})} \right)^{\dfrac{1}{1-\frac{1}{\gamma}}} - 1 \right] \times 100$$

where $\Omega_{t=0}$ and $\Omega_{t=1}$ denote the vector of behavioral, technology and policy parameters associated with the status quo (the initial steady state) in time $t = 0$ and a reformed economy in $t = 1$, respectively.

5 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, whereas 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 the 2012-2018 key statistics of the Australian economy, a period of relative stability in macroeconomic indicators such as household consumption and asset growth.[23] Externally calibrated parameters are summarized in Table 2. 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 corresponding data moments. These parameters and their targets are in Table 3. 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 4

5.1 Demographics

The model period is one year. Newborn households enter the model economy at age 21 ($j = 1$) as workers, retire at age 65 ($j = J_R$ =45), and can live to the maximum age of 100 ($j = J = 80$).[24] The time-invariant average conditional survival probabilities for males and females ($\psi_{j,m}$ and $\psi_{j,f}$) are computed from the 2001-2019 ABS Life Tables. The growth rate of newborn households 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 family type, $\pi(\lambda)$, is estimated from the HILDA survey. 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 $\pi(\lambda = 2) = 0.16$.[25] Figure 14 reports shares of survivors by marital status over the life cycle.

[23] See an RBA report on wealth and consumption indicators as an example. Furthermore, this period allows us to use policy parameters for the FTB and the CCS from 2018 after major changes to the FTB programs had been introduced (e.g., changes to the FTB A payment rates, income test thresholds and supplements, the FTB B threshold on primary earners, and other changes to tax offsets to streamline the system), and can thus better approximate the current tax and transfer programs.

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

[25] The Australian Institute of Family Studies shows similar figures in their 2018 facts and figures report.

Parameter	Value	Target
Demographics		
Maximum lifespan	$J = 80$	Age 21-100
Mandatory retirement age	$J_R = 45$	Age Pension 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 2012-2018
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	$n_\lambda^m,\ n_\lambda^f$	Age-profiles of average labor hours for employees (HILDA)
Male human capital profile	h_λ^m	Age-profile of wages for men (HILDA)*
Education		
Education level	$\{\theta_L, \theta_H\} = \{0.745, 1.342\}$	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		
Income tax progressivity	$\tau = 0.2$	Tran and Zakariyya 2021*a******
Consumption tax	$\tau^c = 8\%$	$\tau_c \times \dfrac{C_0}{Y_0} = 4.5\%$; given $\dfrac{C_0}{Y_0} = 56.3\%$
Company profit tax	$\tau^k = 10.625\%$	$\tau^k \left(\dfrac{Y - WL}{Y}\right) = 4.5\%$; where $\dfrac{WL}{Y} = 1 - \alpha$
Government debt to GDP	$\dfrac{B}{Y} = 20\%$	Average (CEIC 2012-2018)
Government general purchase	$\dfrac{G}{Y} = 14\%$	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 married men's hourly wage at age 21 (HILDA)*

Table 2: Externally calibrated parameters

Notes: (*) The age-profiles of median hourly wages for married and single men are 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. All resources are generated endogenously in the model. All agents are endowed with base human capital of 1 at the start of lives, equivalent to AUD\$24.02/$hour \times 24 \times 5 \times 52$ before adjusted by work hours (heterogeneity comes from participation decision, hours, education and transitory shocks). (**) Our estimates based on HILDA suggests a wage premium for married men in the range of 1.7-1.8 over the 18 years period 2001-2018. (***) Given progressivity $\tau = 0.2$, we use the scale parameter ζ which controls the size of the tax system as an endogenous tax parameter to to balance post-reform budgets.

Parameter	Value	Target
Households		
Discount factor	$\beta = 0.99$	Saving ratio 5%-8% (ABS 2013-2018)
Taste for consumption	$\nu = 0.375$	LFP rate 68-72% of working-age mothers (HILDA 2012-2018)
Fixed time cost of work	$\{\chi_f,\, \chi_p\} = \{0.1125, 0.0525\}$	Age profile of full-time employment share 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 earnings at age 21, $GINI_{j=1,m} = 0.35$
Fiscal policy		
Maximum pension payment	$pen^{max} = 30\% \times Y$	Pension share of GDP, $\frac{\mathcal{P}_t}{Y_t} = 3.2\%$ (ABS, 2012-2018)

Table 3: Internally calibrated parameters

Notes: (*) We chose age 50 to allow sufficient time for δ_h to take effect on female labor supply decisions. (**) We calibrate the female human capital accumulation and depreciation rates for a type $\{\lambda, \ell\}$ woman such that her age-profile of wages matches 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 HILDA estimates for each pair $\{\lambda, \ell\}$. Some additional adjustments (e.g., by discarding wage data near retirement age) are made to better fit the estimated male profiles since the data for some groups, such as single fathers, is noisy.

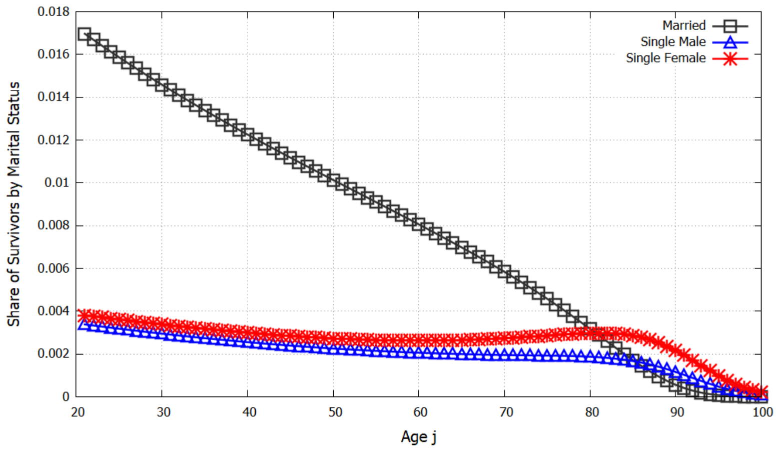

Figure 14: **Time-invariant shares of survivors by family type over the life-cycle.**

5.2 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.[26] The taste for consumption relative to leisure, ν, is calibrated to 0.375 for the female labor force participation rate to stay within the range of 68-72%. The fixed time cost parameters of work, χ_f and χ_p, are calibrated to 0.1125 and 0.0525, respectively, so that the model generated mothers' full-time share of employment matches that in the data.

5.3 Endowments

Labor productivity. Every adult household member is subject to idiosyncratic transitory earnings shocks η^i for $i \in \{m, f\}$. Their shocks follow an identical AR1 process with auto-correlation coefficient, ρ, and variance of the innovation, σ_v^2. We set $\rho = 0.98$ to stay within bound of the common values in the literature and calibrate σ_v to achieve a Gini index of 0.35 for the efficiency wage distribution of men aged 21. This configuration results in an efficiency wage Gini coefficient of 0.3766 (non-target) for the working age male population.[27] The Rouwenhorst method is employed to discretize the shock values into 5 grid points $\{0.29813, 0.54601\, 1, 1.83146, 3.35424\}$ with the following Markov transition probabilities[28]

[26] $\beta = 0.99$ results in the growth-adjusted time discount factor $\tilde{\beta} = \beta(1+g)^{\nu\left(1-\frac{1}{\gamma}\right)} = 0.9807$ for the balanced-growth path steady state economy.

[27] σ_v is used to match the Gini index of the model male efficiency wage distribution with that of the data male earnings (instead of just wages) which include variations in work hours. The reason is that our exogenous male work hour profiles are normalized average values. There is no endogenous source of hour variation; therefore, we use the transitory fluctuation process - that drives the model male efficiency wages - to also capture the exogenous variation in hours for a more realistic model male earnings distribution.

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

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

We assume two education 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 education 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 decisions and women's intensive margin of labor supply decisions, and externally estimate their age-profiles of normalized average work hours (n^m_λ and $n^f_{\lambda,\ell}$) by gender, family type, and employment type. Men always work full-time and follow a pre-determined labor supply paths. Women can choose their labor supply along the extensive margin. Specifically, a household decides whether its female member ought to stay at home ($\ell = 0$), work part time ($\ell = 1$), or work full time ($\ell = 2$).[29] The average work hours are estimated from HILDA as shown in Figure 15.

We estimate the age-profiles of hourly wages for single and married males from the HILDA survey data (2001-2018) and use them as proxies for the male human capital age profiles, h^m_λ. Human capital of female workers, h^f_λ, is governed by the female labor market decisions and therefore evolves endogenously over the life cycle. The human capital gain parameters, $\{\xi_{1,\lambda,\ell}, \xi_{2,\lambda,\ell}\}$, are calibrated by household type (λ) and labor choice (ℓ) such that the life cycle paths of human capital of single and married women mimic those of their respective male counterparts should they choose to work without time off.[30]

Children. Children are deterministic and exogenous. Provided that a plurality of parents (42%) in our sample data have two children, our model households are assumed to have only two children over their lifetime to reduce computational burden.[31] The heterogeneity pertaining to children is attached

[29] Our estimates from HILDA demonstrate that male labor supply profiles remain virtually unchanged across selected demographics such as parental and marital status. We have also conducted several empirical exercises by running logistic regressions of workforce participation on lagged FTB benefits and demographic controls. Results indicate that the work disincentive effect is trivial for men. For fathers, in particular, a \$10,000 increase in the annual FTB transfer is associated with a $1p.p.$ decline in participation but the effect is statistically insignificant at the 95% confidence level (p-value = 0.18). On the contrary, for mothers, the same increase in transfer magnitude is associated with a statistically significant drop in participation by $4.3pp$ (with participation predicted to be 72.68% if the FTB transfer is nil). On a similar note, Doiron and Kalb (2004) finds that the effects of child care cost increase on male labor supply is negligible. Empirical evidence thus far suggests highly inelastic male labor supply. Hence, for our abstract environment that puts a 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 (e.g., through work hour adjustment) in response to male earnings shocks. Tin and Tran 2023 show that spousal labor supply response to primary earner's earnings shocks is weak. From another viewpoint, this behavior may also be driven by government insurance. It is possible that we would no longer see such passiveness from spouses once the child-related transfers are removed. For our current work, however, such complications are computationally demanding and lead to intractability.

[30] Because female extensive labor supply decisions by marital status are the main interest in this study, it is necessary that we discipline their realized human capital trajectories from these choices by matching them to the corresponding male profiles from the data (under the assumption of assortative mating). We could in principle increase the quality of these matching exercises by further separating human capital age-profiles by education; however, this would generate many additional parameters and lead to noisy data moments due to limited sample size on certain demographics such as married households at early age and single households at older age.

[31] We estimate the share of parents with two children by first restricting the sample to older households (aged 50

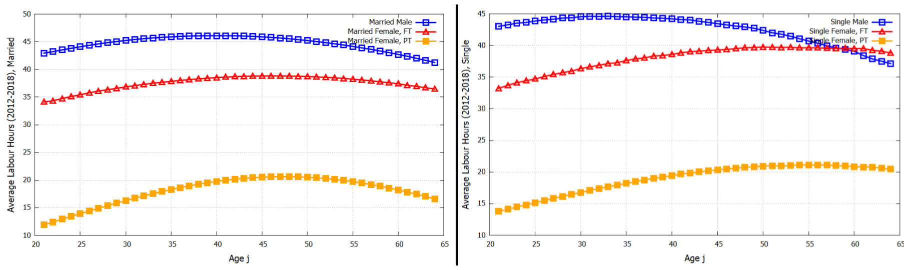

Figure 15: **Labor supply over the life cycle. Left panel:** Age profiles of average work hours for married parents if employed. **Right panel:** Age profiles of average labor hours for single men and single mothers if employed. Note: the difference between the two y-axes. The former ranges from 10 to 50 hours and the latter from 10 to 45 hours.

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 25-37 year-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.[32] For tractability and based on the observation that women constitute the majority (87.21) of lone parents in our sample, we assume only single women and married households in the model have children.[33]

Child care cost. We abstract from informal child care and restrict the formal care service to have identical quality and price. That is, we assume a perfectly competitive market environment and do away with the complexity associated with regional child care cost variations and types of childcare services used. With a conservative estimate of \$12.5 per hour, the cost of child care is 52% of a 21-year-old male 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. We assume the child care cost, κ, declines once children have reached 6 years old (school age). More specifically, working mothers pay the full total cost of formal child care for a child aged 0-5 years old, and one-third of the cost afterwards under the assumption that public schools are free and parents only spend on out of school hours (OOSH) care and other expenses such as extra curricular activities.[34]

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and above). The resultant statistics thus reflect the number of children the households have over their life cycles. Our statistics show that there are 12% of parents with 1 child, 42% with two, 28% with three, and the rest with four or above. Hence, the average number of children in our model is not far off the actual figure.

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

[33] The assumption that all households, except single male, have children is not far from the fertility rate in Australia which hovered around 1.8 per woman between 2012-2018. More precisely, since married and single female households comprise 86% of the population in our modeled economy, the fact that each of these households has 2 children implies that the average number of children per household is $0.86 \times 2 = 1.72$.

[34] OOSH services operate before school (6:30am-9am), after school (3pm-6pm), and during vacation period (7am-7pm). We drop the cost to 1/3 of the original cost to reflect the fact that children of school age spent less time in child care on average (only 40% between aged 6-8 participate in any form of child care and the rate declines to 20% by the age of 12). The cost after age 5 is assumed to also encapsulate other costs incurred by parents. See an AIFS report on child care and early child hood education in Australia for further information on child care usage, and a 2005 DSS report on costs of children for further information on the average cost of caring for a child. We use recent information for the hourly child care cost, and assume the costs of school-age children relative to pre-school-age children remain unchanged since 2005.

5.4 Technology

The production function is $Y = K^{\alpha}(AL)^{1-\alpha}$ 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 9 to derive the capital depreciation rate $\delta = 0.07172$ in the initial steady state equilibrium.

5.5 Fiscal policy

Taxes. We set the progressivity parameter $\tau = 0.2$ (see Tran and Zakariyya 2021*a*) and use the scale parameter ζ, which controls the total tax size given τ, as an endogenous budget balancing variable in all policy experiments. We set $\tau^c = 8\%$ to target the consumption tax share of GDP, $\frac{\tau^c C}{Y}$, of 4.5% given $\frac{C}{Y} = 56.3\%$ according to the ABS 2012-2018 data. We calibrate the company income tax rate to match the company income 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%.

Family Tax Benefit and Child Care Subsidy. We use the policy parameters set by the Australian government in 2018 for the Family Tax Benefit part A and part B and the Child Care Subsidy programs, including base and maximum payment rates, income thresholds and taper rates.

Means-tested Age Pension. 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 a total pension share of GDP of 3.2% in the benchmark steady state economy.

General government expenditure and debt. We define the general government expenditure G as all government expenses other than the two child-related transfers (FTB and CCS) and the Age Pension that the model explicitly accounts for. The 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 prior to the pandemic.

5.6 The benchmark economy

We assess our model performance by comparing between model and data moments.

Aggregate macro variables. We examine selected key target and non-target aggregate macroeconomic variables in the benchmark economy. Table 4 demonstrates that the benchmark model performs reasonably well in matching aggregate data moments.

Life-cycle profiles of labor force participation and full-time share of employment. 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 17 reports the age-profiles of labor force participation and full-time share of employment for mothers from the data and those generated by the benchmark model. Our model performs reasonably

Moments	Benchmark economy	Data	Source
Targeted			
Capital, K/Y	3.2	3-3.3	ABS (2012-2018)
Savings, S/Y	4.7%	5-8%	ABS (2013-2018)
Mothers' labor participation, LFP	72.57%	68-72%	HILDA (2012-2018)*
Consumption tax, T^C/Y	4.23%	4.50%	APH Budget Review
Corporate profit tax, T^K/Y	4.25%	4.25%	APH Budget Review
Age Pension, P/Y	3.65%	3.20%	ABS (2012-2018)
Gini coefficient (male aged 21)	0.35	0.35	HILDA (2012-2018)
Non-targeted			
Consumption, C/Y	52.80%	54-58%	ABS (2012-2018)
Investment, I/Y	32.29%	24-28%	ABS (2013-2018)
Mothers' full-time share	50.32%	50%	HILDA (2012-2018)
Scale parameter, ζ	0.7417	0.7237	Tran and Zakariyya 2021*b*
Income tax, T^I/Y	14.93%	11%	APH Budget Review
Tax revenue to output	28.36%	25%	ABS(2012-2018)
Child-related transfers (FTB + CCS)	1.7%	1.45%	ABS (2012-2018)

Table 4: **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.

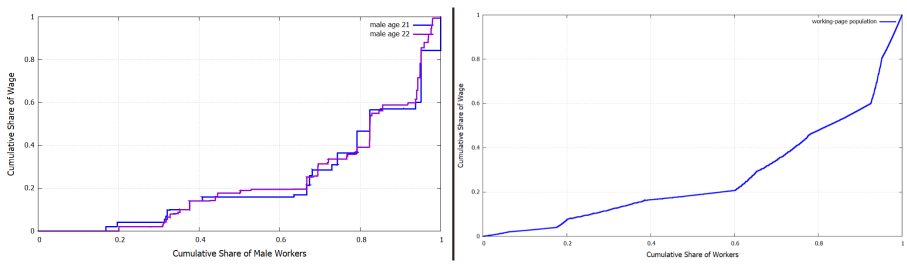

Figure 16: **Lorenz curves of wage distributions. Left panel:** Lorenz curves of the distributions of married male wages at age 21 and 22 (Gini = 0.35). **Right panel:** Lorenz curve of the wage distribution of working-age male population (Gini = 0.3766). Wages in the model account for human capital, education and transitory shocks over the life-cycle .

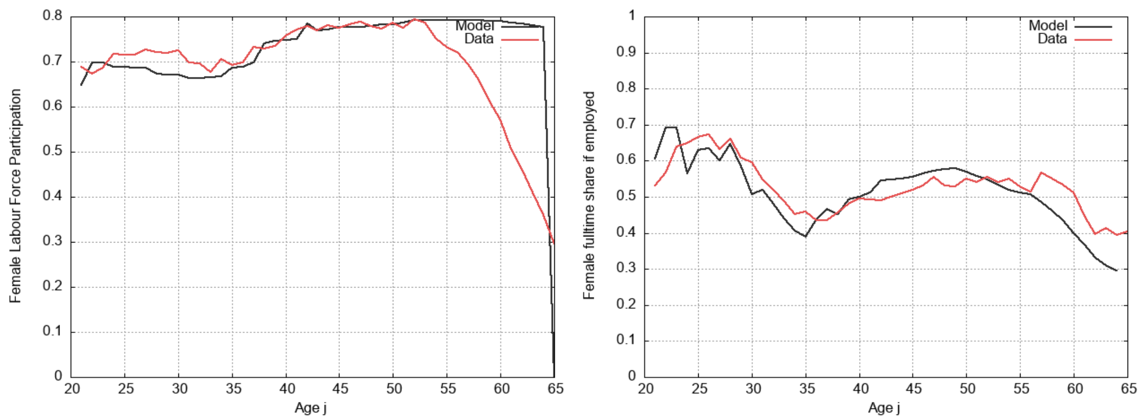

Figure 17: **Model vs Data: Life-cycle profiles of labor supply of mothers. Left panel:** Life cycle profile of labor force participation. **Right panel:** Life cycle profiles of full-time share of employment.

well in matching the two age-based data moments until approximately age 55, after which the model and data labor force participation rates begins to diverge. This can be attributed to two main assumptions made to ease computation: (i) exogenous work hour profiles and mandatory retirement, and (ii) exogenous children. First, the inability to adjust work hours when young and the mandatory retirement at age 65 imposed on economic agents in the model means more mothers have to work until retirement to offset the absence of labor earnings afterwards and to insure against longevity risk. Second, exogenous children, with births restricted to around the first 10 years of working age, could overstate the average labor supply path since older mothers are excluded from consideration.

6 Quantitative analysis

In this section, we study whether child-related transfers are socially desirable, and if they are, whether they should be means-tested or universal. We address the first question by considering three radical reforms to the current status quo policies: (i) abolishing the FTB, (ii) abolishing the CCS, and (iii) abolishing both the FTB and the CCS. Then, we examine the impact of the universal child-related transfer scheme by comparing its efficiency and welfare outcomes to the benchmark means-tested program. In section 6.3), we extend the analysis by assessing the aggregate implications of simple incremental regime changes and alternative universal schemes. Any discrepancies between the government's consolidated tax revenue and expenditure are financed by adjusting the income tax rate.

6.1 Eliminating child-related transfer programs

We begin our quantitative analysis with three counterfactual policy experiments, abolishing either the FTB, the CCS, or both the FTB and the CCS.

	Abolishing one or both child-related transfer programs		
	[1] No FTB	[2] No CCS	[3] No FTB&CCS
CCS size, %	+49.80	–	–
FTB size, %	–	+10.89	–
Average tax rate, *pp*	+2.50	-0.70	+0.99
Fe. Lab. For. Part. (LFP), *pp*	+5.76	-10.00	+10.49
Fe. Full time (FT), *pp*	+9.21	-4.55	+20.38
Human cap. (H), %	+3.88	-4.83	+8.57
Consumption (C), %	+1.10	-3.26	+4.27
Output (Y), %	+1.38	-3.48	+3.86
Welfare (EV), %	-3.70	-1.00	-0.66**

Table 5: **Aggregate effects of eliminating child-related transfer program(s)**

Notes: Results are reported in terms of percentage changes relative to the levels in the benchmark economy.

Abolishing the FTB or the CCS: The first and second columns of Table 5 show the aggregate efficiency and welfare consequences of abolishing the FTB (retaining the CCS) and the CCS (retaining the FTB), respectively. Eliminating the FTB removes the work disincentive effect associated with the program, and as anticipated, leads to a boost in labor supply. There is a 5.76*pp* increase in female workforce participation, with an even stronger 9.21*pp* increase in full-time rate. This suggests a post-reform switch from part-time to full-time work by a sizeable portion of mothers. On the whole, discontinuing the FTB program raises output by 1.38%, which makes it an attractive option from the efficiency perspective. However, this new regime also brings about an ex-ante welfare loss of 3.7% relative to the status quo, likely driven by the loss of leisure in the new steady state. A society that places its concern on the long-run welfare of its newborns would oppose this reform.

The same society would be averse to eliminating the CCS. Without the subsidy to reduce formal child care costs and offset the FTB's work disincentive, labor force participation falls by 10*pp*, with a 4.55*pp* drop in full-time rate. This drop in full-time participation can partly be attributed to the CCS's work activity test which grants larger benefit for full-time work. In total, output and welfare fall by 3.48% and 1%, respectively, making eliminating the subsidy a lose-lose reform.[35]

From these experiments, two lessons emerge. First, the general equilibrium effect via tax channel from eliminating either program is small. The first and second experiments are associated with 2.55*pp* and -0.70*pp* in average tax rate changes, respectively. The lack of budget-saving effect might stem from: (i) the targetedness of child-related transfers via means-testing which curtails baseline government spending, and (ii) the interplay between the two programs (e.g., eliminating the FTB increases labor supply and thus results in an expansion of the CCS, negating the budget-saving effect).[36] Second, of relevance to policy making, while both reforms cause welfare reductions, removing the means-tested lump sum transfer (FTB) produces some efficiency gains in the form of higher labor supply, human capital and output, whereas the removing the subsidy (CCS) offers no such benefit.

Abolishing the FTB and the CCS: The total elimination of all child-related transfers in the third experiment means that the positive and negative artificial incentive effects on labor supply are removed altogether. These forces combine and result in significant rises in female workforce participation by 10.49*pp* and full-time rate by 20.38*pp*, with a consequent 3.86% output increase. The efficiency effect more than doubles that of just abolishing the FTB scheme. The large increases in labor supply and output could lead to bracket creep, which accounts for the slight 0.99% uptick in the average tax rate, even with the reduced tax burden from not having to fund child-related transfers.

C (%)	M (H)	M (L)	SM (H)	SM (L)	SW (H)	SW (L)
Age 21-30	+8.12	+15.74	-0.11	-0.07	-7.74	-11.55
Age 31-40	+14.59	+14.83	-0.06	-0.06	-3.04	-6.88
Age 41-50	+9.65	+6.71	-0.03	-0.01	-4.20	-9.39
Age 51-60	+6.80	+6.59	+0.03	+0.07	-3.22	-8.03
Age 61-70	+6.24	+5.69	+1.12	+1.44	-1.32	-6.00
Age 71-80	+6.61	+4.10	+6.10	+6.36	+1.66	-3.09
Age 81-90	+5.48	+1.80	+9.83	+9.11	+2.13	-3.06
Welfare (%)	+1.35	-0.22	+0.02	+0.06	-4.03	-6.53

Table 6: **Heterogeneous consumption and welfare effects of abolishing the FTB and the CCS** (M: Married, SM: Single men, SW: Single women (Single mothers); H: High education and L: Low education).
Notes: Results are reported in terms of percentage changes relative to the levels in the benchmark economy.

Ultimately, the efficiency improvement also results in a 4.27% increase in the aggregate consumption. The puzzle is the 0.66% welfare loss for newborn households, despite the notable consumption and output gains. This loss is attributable partly to the loss of leisure and partly to the modeling of

[35]Considering the shorter coverage of the subsidy (only for children aged 13 or younger), the impact of reforming the CCS is most significant on younger mothers.

[36]In a progressive tax context, rising income might push more people into the higher tax bracket which can cause the average tax rate in the economy to rise passively.

family structure. In a setup without heterogeneity in family type, all households would have identical self-insurance capabilities by adjusting their work and savings in response to regime shifts. Differently, in a model as ours that features family structure and children, single and low-education married mothers have limited family insurance. In fact, single mothers lack family insurance entirely and have limited self-insurance due to the pecuniary and non-pecuniary child penalties. The elimination of child-related transfer programs exacerbates their vulnerabilities by taking away the last form of insurance, the government insurance (as reflected by the increased consumption growth variation in Figure 18). Consumption changes observed in the last two columns of Table 6 further demonstrate that their supplementary labor earnings, as they seek to compensate for the loss of government assistance, cannot replace the lost child benefits. Without the CCS, the monetary cost of formal child care substantially diminishes their returns to labor. Furthermore, the additional time commitment for working mothers implies that their extra labor supply come at a great sacrifice of leisure.

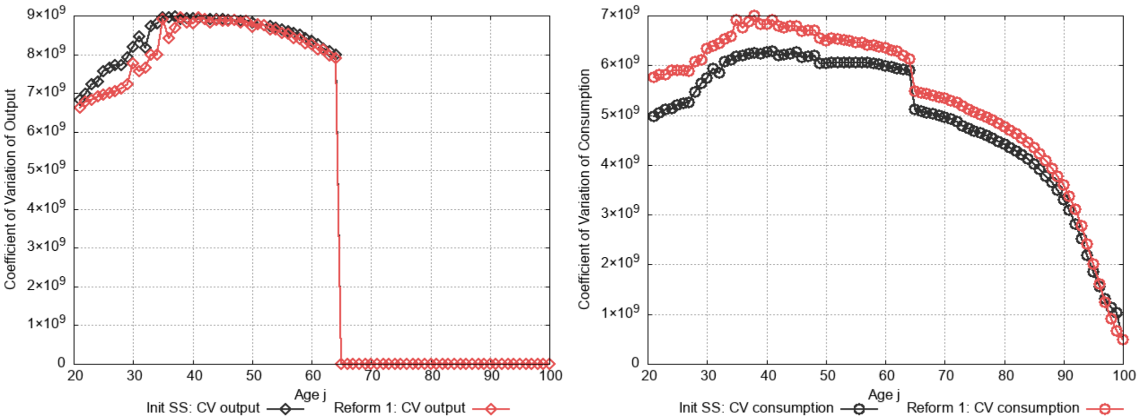

Figure 18: **Coefficients of variation of log output and log consumption: Benchmark (black) vs FTB and CCS elimination reform (red). Left panel:** Life cycle profile of coefficient of variation of log output. **Right panel:** Life cycle profile of coefficient of variation of log consumption.

The factors aforementioned explain the sharp welfare reductions for single mothers. As seen in the final row of Table 6, welfare plummets by 4.03% for highly-education single mothers and 6.53% for those with low education. In contrast, for married mothers with low education, the family insurance provided by their partner mitigates the loss, keeping it relatively small at 0.22%. Hence, a society concerned with the long-term welfare and equity outcomes for its newborns would not favor the complete removal of child-related transfer policies.

6.2 Means-testing or universal

6.2.1 Empirical context

For context, we begin by providing empirical estimates related to the predominant component of the FTB transfer, the FTB-A. Specifically, we utilize the HILDA tax-benefit model to compute the potential average payment and the share of beneficiaries stratified by income and wealth deciles, prior to applying the income test. The visual data presented in Figure 19 and 20 shed light on what a universal scheme might look like in practice. First, if the scheme was universal, all eligible parents would be entitled to the maximum payment, rendering the base payment irrelevant. Second, while households in the lower deciles could accrue benefits ranging from $AU\$9,000$ to $AU\$10,000$, those better off, particularly households above the median income or wealth, could still secure approximately

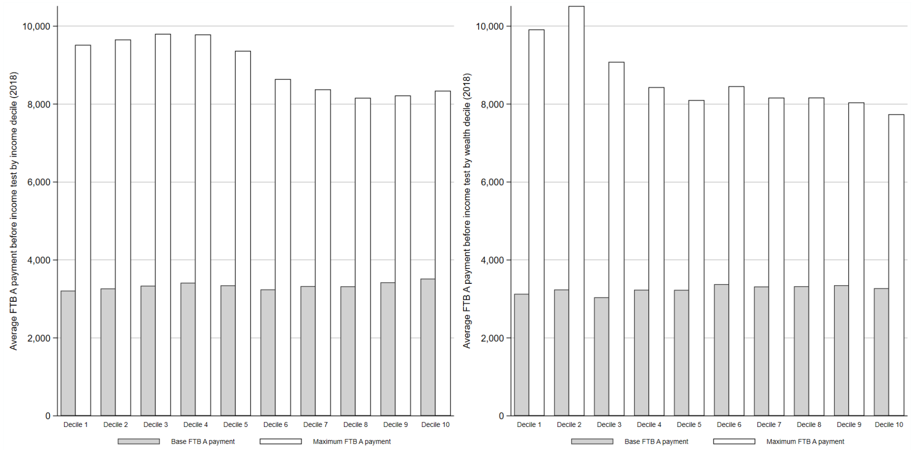

Figure 19: **Average FTB A base and maximum benefits before income test by income and wealth deciles of 2018**

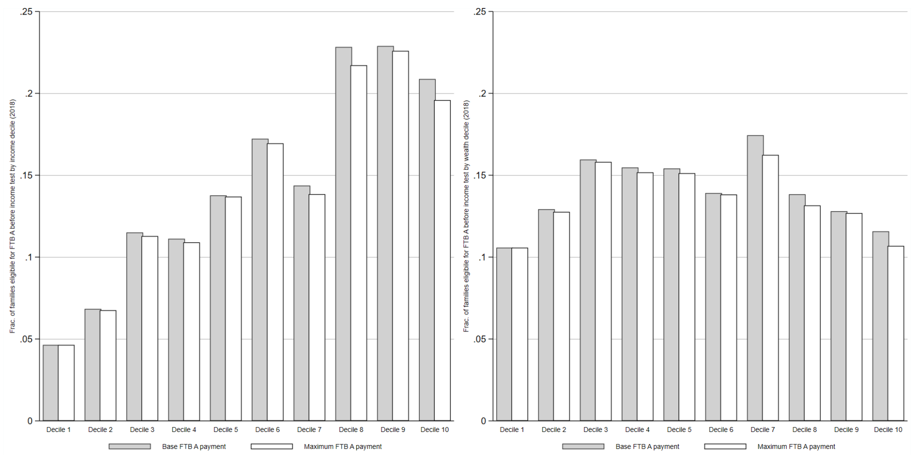

Figure 20: **Potential beneficiaries before income test by income and wealth deciles in 2018**

$AU\$8,000$. Third, according to Figure 20, which illustrates the hypothetical extensive margin of the universal FTB-A, we also observe that a significant fraction of richer households would be eligible for the transfers. The increases in the intensive and extensive margins imply the program would expand greatly and intensify the tax burden. Therefore, depending on how the tax channel operates, the outcome could be efficiency and welfare losses and/or welfare transfers to more affluent households. A detailed quantitative analysis of this scenario ensues in the subsections below.

6.2.2 Efficiency and welfare consequences of universalizing child-related transfers

Through the lens of our model, we quantify the effects of a radical reform under which the government removes all the means-testing rules and provides universal child-related lump sum payments and work subsidies to all families with dependent children. Table 7 details the outcomes of this transition. Our results indicate that rendering the FTB and the CCS universally accessible is efficiency and welfare improving. Remarkably, despite the associated 4.2*pp* higher tax burden and the positive income effect of the FTB transfers, the work incentive effect from removing means-testing is dominant. Labor force participation and work hours of mothers increase, culminating in female human capital and output gains of 2.09% and 0.11%, respectively. Moreover, the ex-ante welfare increases by 0.85%.

Aggregate implications of universal FTB and CCS programs			
CCS size, %	+129.45	Hour, %	+6.71
FTB size, %	+281.40	Human cap. (H), %	+2.09
Average tax rate, *pp*	+4.20	Consumption (C), %	+0.04
Fe. Lab. Force Part. (LFP), *pp*	+2.64	Output (Y), %	+0.11
Fe. Full time (FT), *pp*	+4.39	Welfare (EV), %	+0.85

Table 7: **Aggregate effects of universalizing the FTB and the CCS.**

Notes: Results are reported in terms of percentage changes relative to the levels in the benchmark economy.

In aggregate terms, universal child-related transfers, rid of means-testing devices, seem to outperform the status quo in all key metrics. However, the aggregate changes mask the heterogeneous effects. For better understanding, Table 8 investigates further into labor supply responses by family types. The absence of means-testing under the universal structure ensures working mothers across all income levels are eligible for the maximum FTB transfers. This eliminates the work disincentive associated with income tests. Moreover, the universally accessible CCS program, awarding maximum subsidies, provides an extra layer of incentive. For most households, the work incentive appears to dominate the work disincentive stemming from the FTB lump sum transfers and the higher average tax rate. As evident in Table 8, labor supply sees a boost among married mothers, with the most pronounced response coming from those with low education who also constitute the majority.[37]

Interestingly, single mothers' labor supply remains largely unchanged, with only a minor fraction transitioning out of full-time employment. There are three potential channels through which the observed effects manifest. First is the availability and strength of self and family insurance against consumption fluctuations. Lacking family insurance, single mothers rely on self-insurance to smooth consumption over their life cycle. They are thus more likely to stay in the labor force, disregarding policy changes. The second channel is the tax system's progressiveness, which means the increased tax burden is felt most at higher-income bracket and is generally smaller for low-education single mothers.

[37] Recall from subsection 5.1 and 5.3 that out of all households in our economy, 70% are couples, and 70% have low education.

Labor supply responses by mothers to universalized child-related transfers											
LFP (*pp*)	21-30	31-40	41-50	51-60	61-70	**FT** (*pp*)	21-30	31-40	41-50	51-60	61-70
M (H)	+0.0390	+0.3347	+0.1323	+0.0126	-0.0161	M (H)	+0.4783	+1.0791	-0.0287	-0.0879	-0.0814
M (L)	+0.9228	+0.7844	+0.3895	+0.0542	-0.0153	M (L)	+2.3560	+0.4973	+0.3216	+0.0178	-0.0855
S (H)	0	0	0	-0.0003	-0.0004	S (H)	-0.0305	-0.0192	-0.0036	-0.0088	0
S (L)	0	0	-0.0001	-0.0005	+0.0009	S (L)	+0.0131	-0.0276	-0.0015	-0.0042	+0.0032
			Hour (%)	21-30	31-40	41-50	51-60	61-70			
			M (H)	+6.33	+21.87	+1.69	-1.25	-6.12			
			M (L)	+28.49	+9.42	+4.64	+0.60	-3.11			
			S (H)	-1.26	-1.40	-0.32	-0.89	-0.12			
			S (L)	+0.24	-0.88	-0.06	-0.20	+0.48			

Table 8: **Heterogeneous labor supply responses by married (M) and single (S) female households to universal child-related transfers** (H: high education, and L: low education)**.**
Notes: Results are reported in terms of percentage changes relative to the levels in the benchmark economy.

Third, the lack of work hour decision in our model might partially explain why single mothers' labor supply is unresponsive to reforms.[38]

C (%)	M (H)	M (L)	SM (H)	SM (L)	SW (H)	SW (L)
Age 21-30	+4.56	+12.70	-4.12	-3.65	-3.64	-1.12
Age 31-40	+8.59	+6.18	-4.11	-3.90	-1.69	-2.65
Age 41-50	+3.82	+2.40	-4.08	-3.97	-0.96	-2.25
Age 51-60	+2.92	+2.30	-4.03	-3.97	-1.05	-2.30
Age 61-70	+3.02	+2.56	-3.35	-3.13	+0.15	-0.93
Age 71-80	+3.81	+2.54	-0.31	-0.44	+2.34	+1.03
Age 81-90	+3.53	+2.12	+1.96	+1.21	+3.08	+1.70
Welfare (%)	+1.36	+1.34	-1.47	-1.20	-0.69	-0.51

Table 9: **Heterogeneous household consumption and welfare responses to universal child-related transfers** (M: Married, SM: Single men, SW: Single women (Single mothers); H: High education and L: Low education)**.**
Notes: Results are reported in terms of percentage changes relative to the levels in the benchmark economy.

From an efficiency standpoint, the heterogeneous effects seem to align with the broader picture. In contrast, the degree of redistribution illustrated in Table 9 may shape a different narrative regarding the welfare implications. Married households emerge as the sole winner of this reform. Both low- and high-education couples see substantial increases in consumption over their lifetime, such that their welfare measures increase by roughly 1.3% even as the wives work more. Given that these households represent 70% of the model's population, the reform would likely win the majority vote and be adopted.

On the other hand, all single households, including single mothers—who are the primary target of the program—are the losers under the universal system. The main source of their loss seems to be

[38]Note that, this is also a result of the 'small open economy in the long-run' setting. Perfect cross-border capital mobility maintains fixed factor prices. In a closed economy, the influx of labor into the market would put a downward pressure on wages and dampens the effect of the reform.

the large 4.2*pp* surge in the average tax rate in the new economy to finance the FTB and the CCS which inflate by 281.4% and 129.45%, respectively, relative to the benchmark system. Single men are inevitably the most adversely affected as they reap no transfer benefit and have to pay a higher tax. Particularly, high-education single men bear the largest penalty due to the progressive tax system.

The surprising welfare outcome is those of single mothers. High-education single mothers see a decline in their welfare by 0.69%, while their low-education counterparts register a 0.51% dip. It is worth noting that, they maintain their pre-reform labor supply commitment despite the introduction of the universal program. This suggests that for single mothers, the benchmark payment rate (limited to the duration when young children are in the household) is not adequate to replace the labor income and human capital they gain over the life cycle from working. Consequently, although the increased tax burden in the counterfactual economy has virtually no effect on single mothers' labor supply, it serves to lower their consumption over the greater part of their life cycle, leading to welfare loss as evident from the last two columns of Table 9.

The universal system, while seemingly affordable given the modest scale of child-related transfers in the initial steady state, still imposes a significant tax burden. The enlarged labor supply, predominantly from low-education married mothers who typically have low earnings, makes minimal contribution to the tax base due to the system's progressiveness. As a result, even when the added tax does not completely erode the overall efficiency gains, it places enough burden on single households to reduce their welfare. A society that prioritizes the welfare of its worse-off members might reject this universal reform.

6.3 Extensions

To be consistent with our ongoing discussion, a reform is deemed superior to the status quo if it satisfies three criteria. First, it must enhance the aggregate efficiency. Second, it must elevate the welfare of newborn households. Lastly, the reform should not disproportionately favor the majority to the detriment of the minority. With these criteria as our guide, this subsection explores several hypothetical economies involving simple incremental changes to a single policy parameter at a time, holding all else constant, to see whether there exists any potential reform capable of fulfilling all the objectives.

6.3.1 Efficiency and welfare consequences of incremental reforms to means-test parameters

Searching for efficiency and welfare improving reforms in a model with an extensive state space and complex policy mechanisms is challenging, especially when considering changes to multiple means-test parameters concurrently. However, by narrowing our scope to the several simple cases presented below, we can still extract some important takeaways.

Table 10 displays the efficiency and welfare outcomes from chosen incremental reforms. There are notable observations. First, the top row (tax rate changes) shows that, in a model with progressive tax and family heterogeneity, the interactions of multiple channels of effects are such that the tax outcome cannot be readily predicted. Second, a glance at the bottom two rows (output and welfare changes, respectively) reveals that most of the considered counterfactual regimes involve trade-offs between efficiency and welfare. Third, relaxing the taper rates on the CCS, as seen in the second to last column of Table 10, stands out as a reform that improves both efficiency and welfare.

Aggregate implications of incremental reforms								
	FTB payment rates		CCS subsidy rates		FTB taper rates		CCS taper rates	
	$0.5 \times tr$	$1.5 \times tr$	$0.5 \times sr$	$1.5 \times sr$	$0.5 \times \omega^F$	$1.5 \times \omega^F$	$0.5 \times \omega^C$	$1.5 \times \omega^C$
Tax rate, *pp*	-0.36	+0.19	-1.37	+0.69	+2.08	+3.34	-0.97	+1.28
Fe. LFP, *pp*	-5.65	+1.00	+1.13	-2.87	+1.69	-2.94	+0.17	-2.66
Fe. Hour, %	-10.89	+3.67	+3.28	-5.05	+1.13	-5.47	+1.00	-5.32
Fe. Human Cap, %	-4.95	+0.93	+0.92	-2.22	+0.76	-2.21	+0.22	-2.49
Cons. (C), %	-2.41	+1.03	-0.17	-1.09	+1.36	-1.55	+0.46	-2.06
Output (Y), %	-1.52	+2.20	+0.88	-1.08	+0.81	-1.67	**+0.89**	-1.42
Welfare (EV), %	-0.41	-0.02	-0.82	+0.28	-0.44	-1.41	**+0.37**	-0.61

Table 10: **Aggregate efficiency and welfare effects of incremental reforms to means-test parameters**
Notes: Results are reported in terms of percentage changes relative to the levels in the benchmark economy. Let tr denote the FTB payment rates, sr denote the CCS subsidy rates, ω^F denote the FTB taper rates, and ω^C denote the CCS taper rate (a reciprocal of the taper unit which is the amount of income increment by which the subsidy rate falls by $1pp$). ϕ_p is a scaling factor that scales a particular policy parameter up or down by a certain factor. For example, $\phi_p \times tr^{FTB}$ when $\phi_p = 1.5$ means that the FTB payment rates are increased 1.5 times.

This reform generates a comparatively moderate overall welfare gain of 0.37% relative to the 0.85% gain realized under the universal system. Yet, unlike the universal system which is a welfare transfer to married households at the expense of their single peers, relaxing the CCS taper rates spread the welfare gains more evenly across households, as demonstrated in Table 11. Easing the CCS taper rates, therefore, meets all our set criteria, plausibly due to its lesser fiscal impact and thus smaller tax penalty on labor earnings of single households.

However, the model suggests that implementation might encounter roadblocks. A society that judges a reform on the merits of its long-run welfare effects might still prefer universalizing child-related transfers over incrementally adjusting the subsidy's taper rates. To see why, recall that high-education and low-education married households (constituting the majority) experience welfare gains of 1.36% and 1.34%, respectively, under the universal regime, albeit at the expense of the single households (Table 9). The incremental approach via halving the CCS taper rates ensures a more balanced distribution of gains, but welfare for the average married households only increases by approximately 0.4%. When put to a majority vote, the universal child-related transfer system would still likely secure the most votes.

The findings above resonate with a common understanding that larger aggregate welfare gains do not necessarily translate to equity, nor does a complete overhaul of the existing means-tested framework ensure it. Universalizing the benchmark child-related transfers is not a Pareto improvement. A less radical reform, such as reducing the CCS taper rates, can potentially yield moderate gains across multiple dimensions and be more equitable, but whether it can garner support from the majority remains uncertain. Finally, although a more exhaustive search over combinations of multiple policy adjustments might uncover more preferable alternatives, we leave this issue for subsequent studies.

6.3.2 Efficiency and welfare consequences of universal child-related transfers varied by payment rates

Is there a case for a universal child-related transfer system considering our efficiency, welfare and equity objectives? Subsection 6.2.2 shows how the adverse redistributive effect via the tax channel can result

C (%)	M (H)	M (L)	SM (H)	SM (L)	SW (H)	SW (L)
Age 21-30	+1.59	+1.89	+0.98	+0.76	+0.95	+1.06
Age 31-40	+1.72	+1.25	+0.99	+0.86	+1.15	+0.77
Age 41-50	+1.48	+1.12	+1.01	+0.92	+1.02	+0.54
Age 51-60	+1.30	+1.13	+1.02	+0.96	+1.05	+0.60
Age 61-70	+1.22	+1.07	+1.05	+1.00	+1.17	+0.76
Age 71-80	+1.20	+0.99	+1.16	+1.03	+1.16	+0.87
Age 81-90	+1.15	+0.93	+1.19	+1.01	+1.13	+0.88
Welfare (%)	+0.42	+0.40	+0.34	+0.24	+0.26	+0.18

Table 11: **Heterogeneous household consumption and welfare responses to halving the CCS taper rates** (M: Married, SM: Single men, SW: Single women (Single mothers); H: High education and L: Low education)**.**
Notes: Results are reported in terms of percentage changes relative to the levels in the benchmark economy.

in the universal system harming single mothers, the very group it aims to support. This is mainly due to the excessive fiscal expansion. A potential remedy is controlling the program expenditure by reducing the benefit rates (i.e., the FTB payment and the CCS subsidy rates). To this end, we explore the effects of varying the generosity of the universal system by examining two contrasting scenarios: (i) a universal child-related transfer program that is 50% smaller, and (ii) another that is 50% larger relative to the baseline universal system discussed in subsection 6.2.2.

	Universal child-related transfers varied by payment and subsidy rates		
	0.5×Baseline rates	Baseline rates	1.5×Baseline rates
CCS size, %	−15.45	+129.45	+207.27
FTB size, %	+132.56	+281.40	+430.23
Average tax rate, *pp*	+0.15	+4.20	+6.13
Fe. Lab. For. Part. (LFP), *pp*	+1.06	+2.64	+3.91
Fe. Full time (FT), *pp*	+0.23	+4.39	+6.29
Human cap. (H), %	+0.40	+2.09	+3.09
Consumption (C), %	−0.03	+0.04	+0.08
Output (Y), %	+0.16	+0.11	+0.11
Welfare (EV), %	+0.27	+0.85	+1.50

Table 12: **Aggregate efficiency and welfare effects of universal child-related transfers varied by size**
Notes: Results are reported in terms of percentage changes relative to the levels in the baseline economy. For ease of comparison, the middle column shows the aggregate changes associated with the universal scheme at the baseline rates from subsection 6.2.2 again.

A key takeaway from Table 12 and 14 is that adjusting the size of universal child-related transfers does not resolve the inequity issue. Expanding the system worsens it. As shown in column 3 of Table 12, raising the baseline universal FTB and CCS rates by 50% adds a significant stress to the tax system. The average tax rate jumps by 6.13*pp*, approximately 2*pp* more than the tax increase under the baseline universal system (Column 2). The elevated tax burden then magnifies the negative effects on life cycle consumption of single households. Single mothers, the primary beneficiaries, do not view this increased generosity as a gift. For the reasons discussed in subsection 6.2.2, such as their lack of family insurance and the limited duration of the transfers, the larger tax burden compared to the baseline universal scheme ends up imposing a heavier punishment on their earned income, leading to a welfare decline of 1.3% for high-education single mothers and 0.9% for those with low education.

In contrast, married households see more benefit. Compared to the baseline universal system, the welfare gain increases by 0.2*pp* for high-education couples (from +1.4% to +1.6%) and doubles for low-education couples (from +1.3% to +2.6%).[39] This finding suggests that more generous universal systems can be more inequitable, but they might receive the majority support as they make larger welfare transfers from single households (minority) to married households (majority).

Conversely, halving the universal scheme's generosity, as shown in column 1 of Table 12, delivers smaller overall efficiency and welfare gains but fixes the detrimental welfare impacts that the baseline and expanded schemes have on single mothers. Although the transfers are less generous, the net outcome for single mothers is positive due to the accompanying smaller tax burden (up by only 0.15*pp*) which does not overshadow the benefits. Accordingly, consumption trajectories for both low- and high-education single mothers increase, leading to welfare gains of 0.1% for the former and 0.4% for the latter. However, the system remains inequitable. Single men still lose from the higher tax rates, and now the welfare of low-education married households drops slightly by 0.02%. In any event, because low-education couples and single men constitute the majority, this reform is unlikely to pass.

Labor supply responses by mothers												
	0.5×Baseline rates				Baseline rates				1.5×Baseline rates			
LFP (*pp*)	21-30	31-40	41-50	51-60	21-30	31-40	41-50	51-60	21-30	31-40	41-50	51-60
M (H)	−0.0935	+0.0634	+0.0397	−0.0149	+0.0390	+0.3347	+0.1323	+0.0126	+0.0379	+0.3452	+0.1266	+0.0019
M (L)	+0.1662	+0.5453	+0.3592	+0.0440	+0.9228	+0.7844	+0.3895	+0.0542	+2.1401	+0.9600	+0.3522	+0.0051
S (H)	0	0	0	−0.0004	0	0	0	−0.0003	0	0	0	−0.0004
S (L)	0	0	−0.0002	−0.0018	0	0	−0.0001	−0.0005	0	0	−0.0001	−0.0002
FT (*pp*)	21-30	31-40	41-50	51-60	21-30	31-40	41-50	51-60	21-30	31-40	41-50	51-60
M (H)	+0.1906	+0.0613	−0.0649	−0.0746	+0.4783	+1.0791	−0.0287	−0.0879	+0.5678	+1.3883	−0.1174	−0.1880
M (L)	−0.2479	+0.1150	+0.1595	+0.0119	+2.3560	+0.4973	+0.3216	+0.0178	+4.1052	+0.5985	+0.4306	+0.0131
S (H)	+0.0035	+0.0365	−0.0034	−0.0078	−0.0305	−0.0192	−0.0036	−0.0088	−0.0318	−0.0301	−0.0038	−0.0091
S (L)	+0.03	+0.0710	−0.0013	−0.0039	+0.0131	−0.0276	−0.0015	−0.0042	−0.0318	−0.1518	−0.0018	−0.0050
HOURS (%)	21-30	31-40	41-50	51-60	21-30	31-40	41-50	51-60	21-30	31-40	41-50	51-60
M (H)	+1.60	+1.88	−0.29	−1.51	+6.33	+21.87	+1.69	-1.25	+7.47	+26.81	+0.33	−3.12
M (L)	−1.31	+4.78	+3.44	+0.48	+28.49	+9.42	+4.64	+0.60	+52.70	+11.41	+5.05	+0.14
S (H)	+0.14	+2.66	−0.30	−0.79	−1.26	−1.40	−0.32	−0.89	−1.31	−2.20	−0.34	−0.91
S (L)	+0.55	+2.27	−0.06	−0.25	+0.24	−0.88	−0.06	−0.20	−0.58	−4.86	−0.07	−0.22

Table 13: **Heterogeneous labor supply responses by married (M) and single (S) female households to universal child-related transfers varied by transfer size** (*H*: high education, and *L*: low education)**.**
Notes: Results are reported in terms of percentage changes relative to the levels in the baseline economy.

Why do low-education couples lose? The lower average tax rate allows for increases in their full-time work, labor earnings, and thus, consumption by 3-4% consistently post age 30. However, it turns out that these later-in-life gains, stretching over 70 years, cannot counterbalance their initial consumption loss of 0.7% (Table 14) and loss of leisure over the life cycle (Table 13), and ultimately result in the 0.02% welfare loss. Table 14 might help explain this puzzle. The changes in consumption profiles of young low-education married households across the three experiments, corresponding to the second column of each panel in Table 14, suggest that welfare changes for these households are driven mainly by their early-life consumption. To illustrate, when juxtaposing their consumption changes between the contracted (left panel), the baseline (middle panel) and the expanded (right

[39] Married women's more flexible labor supply decisions might allow their households to optimize more effectively under the new regime.

Consumption and welfare changes by household type																		
	0.5×Baseline rates						Baseline rates						1.5×Baseline rates					
C (%)	M (H)	M (L)	SM (H)	SM (L)	SW (H)	SW (L)	M (H)	M (L)	SM (H)	SM (L)	SW (H)	SW (L)	M (H)	M (L)	SM (H)	SM (L)	SW (H)	SW (L)
21-30	+3.6	−0.7	−0.1	−0.1	+0.4	+0.8	+4.6	+12.7	−4.1	−3.7	−3.6	−1.1	+5.1	+21.4	−6.2	−5.6	−5.2	−3.8
31-40	+5.0	+3.5	−0.1	−0.1	+3.0	+1.5	+8.6	+6.2	−4.1	−3.9	−1.7	−2.7	+9.9	+9.2	−6.1	−5.9	−3.9	−5.0
41-50	+3.9	+3.5	−0.1	−0.1	+2.9	+1.2	+3.8	+2.4	−4.1	−4.0	−1.0	−2.3	+4.0	+3.3	−6.1	−5.9	−3.0	−4.0
51-60	+3.5	+3.7	−0.1	−0.1	+2.8	+1.2	+2.9	+2.3	−4.0	−4.0	−1.1	−2.3	+3.0	+3.1	−6.0	−5.9	−3.0	−4.1
61-70	+3.8	+4.1	+0.3	+0.3	+3.4	+1.8	+3.0	+2.6	−3.4	−3.1	+0.2	−0.9	+3.1	+3.3	−5.1	−4.7	−1.5	−2.1
71-80	+4.6	+3.8	+2.3	+2.0	+4.2	+2.8	+3.8	+2.5	−0.3	−0.4	+2.3	+1.0	+4.0	+3.3	−1.3	−0.9	+1.7	+0.9
81-90	+4.3	+3.1	+3.7	+2.8	+4.4	+2.9	+3.5	+2.1	+2.0	+1.2	+3.1	+1.7	+3.6	+2.7	+1.5	+1.4	+2.8	+2.0
Welfare (%)	+1.4	−0.02	−0.04	−0.02	+0.4	+0.1	+1.4	+1.3	−1.5	−1.2	−0.7	−0.5	+1.6	+2.6	−2.2	−1.9	−1.3	−0.9

Table 14: **Heterogeneous household consumption and welfare responses to universal child-related transfers varied by transfer size** (M: Married, SM: Single men, SW: Single women (Single mothers); H: High education and L: Low education)**.**

Notes: Results are reported in terms of percentage changes relative to the levels in the baseline economy.

panel) universal transfer regimes, we see that although the second and third regimes bring about less consumption gains (not to mention the longer work hours) for low-education married households in their older years relative to the first, the two larger universal systems still produce moderate welfare gains for these households.

Hence, the findings imply large marginal utilities of consumption for low-education married households at a young age. Given the concavity of iso-elastic utility, this suggests that their consumption levels are too low. There are three factors that can explain this result: (i) assortative mating assumption, (ii) early parenthood which limits self-insurance via work, and (iii) credit constraint in an incomplete market setting which limits self-insurance via savings. First, the assortative mating assumption means low returns to combined labor of low-education couples. Second, the early onset of parenthood impacts these households on multiple dimensions. Having a large family at young age reduces per capita consumption at a time when their human capital is low.[40] Early arrival of children not only introduces extra monetary cost, decreasing the net return to labor, but also adds to the time cost (i.e., fixed leisure cost) of work, limiting the ability of young low-education married mothers to develop human capital. Third, the no-borrowing constraint renders consumption smoothing extremely difficult for young low-education households. While they can work and earn more once their children have grown older, they cannot borrow against their future selves to subsidize consumption during their younger years. These challenges therefore converge to depress their earnings and consumption early in their life cycle. As evident in the left panel of Table 14, the decreased tax burden associated with the smaller universal system might help boost mid- and late-life consumption levels, but this fails to compensate for the initial negative consumption impact.

Two key lessons emerge from the discussion above. First, within the confines of our model, deviating from the baseline payment rates does not address the inequitable redistribution problem of the universal child-related transfer system, nor does it achieve the policy goal to benefit all parents. On the one hand, a larger universal program exacerbates the financial strain on single mothers due to the heavy tax burden it entails. On the other hand, a smaller program alleviates the said burden on single mothers, but it adversely affects low-education married households instead. This suggests

[40] Human capital is set to 1 for all newborn households.

that group-targeted transfers require means-testing. Second, family structure, early parenthood and credit constraint restrict young low-income parents' capacity to self-insure via work and savings. The consequent large marginal utilities of consumption point to a role for government insurance via transfers to relax these limitations and allow low-income parents to better smooth their life cycle consumption.

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 Benefit (FTB) and the Child Care Subsidy (CCS) - into a general equilibrium heterogeneous-agent overlapping generations model to examine their aggregate efficiency, welfare and redistribution implications. Through steady state analyses, our findings reveal that child-related transfers are desirable from the welfare perspective, but they come at some efficiency cost. Means-testing for child benefits is an effective instrument to control the size of public funds; however, it induces work disincentive effects by increasing the effective marginal tax rate (EMTR). A transition from the benchmark means-tested system to a universal system can improve both efficiency and welfare, and is favored by the majority. Nevertheless, this reform unexpectedly leads to a welfare loss of single mothers, the intended beneficiaries of child-related transfers. In an extended analysis, we show that a more incremental reform, such as reducing the CCS taper rates, could potentially offer a fairer distribution of welfare gain, but might lack majority endorsement. As for the universal system, we find that varying the level of its generosity does not resolve its inequitable redistribution problem. Case in point, transitioning from a more generous to a less generous universal scheme simply shifts the burden from single mothers to low-education married households, negatively impacting the latter.

Our results bear significance for quantitative research on public policy design. First, they underscore the importance of incorporating family structure into quantitative analyses as it can influence efficiency and welfare assessments, and thereby policy recommendations. Second, they show that understanding the life cycle impact of a reform is crucial in making sense of the aggregate effects and unveiling the underlying welfare redistribution. For instance, we demonstrate that government insurance can significantly raise ex-ante welfare of low-education parents whose self-insurance abilities early in lives are limited by their family size, parenthood, and credit constraint. Third, simple incremental reforms could lead to a modest but more equitable gain. Last but not least, they suggest that policies interact and one should not consider a policy reform in isolation. For instance, abolishing a policy could lead to an expansion of a related policy instead of alleviating the tax burden.

There are some caveats. First is that our findings are concerned with the long-run outcomes. They abstract from labor market frictions that could hinder immediate responses in the labor market, as well as political frictions that might obstruct the automatic adjustment of a program's spending in reaction to another's reform. Neither is there any administrative overhead that exacerbates the inefficiency of operating multiple complex programs under a single welfare system. We also do not encode the intensive margin of female labor supply into our household decision problem. We assume further that male labor supply is exogenous on grounds that our estimated male participation and work hour profiles are stable across settings, and that they have been found to be inelastic by other studies. While the interplay between the FTB and the CCS dampens a reform effect on tax, large increases in the tax burden from radical reforms (e.g., universal child-related transfers) could, in reality, induce male labor supply responses. Additionally, for computational feasibility, the model economy omits childless couples and childless single women, who might enjoy significant gains from tax reductions.

Furthermore, policies might influence fertility, education, and marriage, especially among low-income households. While we do not explicitly address the effects on education and training, our findings show that some reforms, such as expanding the FTB, could depress female human capital development (in the learning-by-doing sense). For fertility and marriage, we assume they are exogenous, thus precluding household responses on these fronts. With regards to the welfare analysis, the study does not account for the full transitional dynamics between steady states. Therefore, our analysis does not capture the welfare implications for non-newborn generations living in the reform phase. These households, having committed to optimal decision paths upon birth, do not anticipate the reforms we introduce. They might be affected differently from the future generations who are born with full knowledge of the new status quo. We leave these issues for future research.

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Appendix

A Child-related transfer programs in Australia

		2001-05	2006-10	2011-15	2016-20*	Total
Income support payments	Pensions	51.74%	51.35%	57.67%	60.80%	55.79%
	Parenting payments	9.52%	6.58%	5.61%	4.63%	6.39%
	Allowances	14.80%	9.94%	10.62%	11.54%	11.59%
	Total	76.06%	67.87%	73.90%	76.98%	73.77%
Non-income support payments	Family payments	23.09%	24.96%	22.18%	18.02%	21.87%
	Bonus payments	0.00%	5.55%	1.31%	1.38%	2.07%
	Other non-income supports	0.59%	1.40%	2.51%	3.45%	2.10%
	Total	23.68%	31.91%	26.00%	22.85%	26.05%
Other public benefits NEI to classify		0.26%	0.22%	0.10%	0.18%	0.18%

Table A.1: **Components of Australian public transfers over time**
*The welfare and social security transfer accounts for roughly 30% of government revenue in the 2016-2020 period.

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), both of which fall into the non-income support category. Family Tax Benefit has two parts as described below:

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

A.1.1 Program description and formulae

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..

These parameters constitute the main structure of the FTB A program. Their values may vary from year to year. For our purpose, we adopt the 2018 FTB A parameters in the initial steady state equilibrium of the model economy.

We first calculate the per child total base payment, b_A, and the per child total maximum payment, m_A, of the FTB A benefit.

$$\begin{aligned} b_{A,j} = LFS_j + NBS_j + MBA_j + CES_{A,base,j} \\ + ndep_{[0,17],j} \times FTBA_{base_1} \\ + ndep_{[18,24],j} \times FTBA_{base_2} \\ + \mathbf{1}_{\{school=1\}} ndep_{[18,19],j} \times FTBA_{base_3} \\ + \mathbf{1}_{\{school=0\}} ndep_{[18,21],j} \times FTBA_{base_4} \end{aligned} \tag{A.1}$$

$$\begin{aligned} m_{A,j} = LFS_j + NBS_j + MBA_j + RA_j + CES_{A,max,j} \\ + ndep_{[0,12],j} \times FTBA_{max_1} \\ + ndep_{[13,15],j} \times FTBA_{max_2} \\ + ndep_{[16,17],j} \times FTBA_{max_3} \\ + ndep_{[18,24],j} \times FTBA_{max_4} \\ + \mathbf{1}_{\{school=1\}} ndep_{[16,19],j} \times FTBA_{max_5} \\ + \mathbf{1}_{\{school=0\}} ndep_{[16,17],j} \times FTBA_{max_6} \\ + ndep_{[18,21],j} \times FTBA_{max_7} \end{aligned} \tag{A.2}$$

Where *school* is a binary variable for school attendance and $ndep_{[a,b],j}$ denotes the number of children in the age range $[a, b]$ of parents aged j. $FTBA_{base}$ and $FTBA_{max}$ are parameters corresponding to the statutory base and maximum per dependent child payment rates which vary over age of a child. In 2018, $FTBA_{base} = \{2,266.65;\ 0;\ 2,266.65;\ 0\}$ and $FTBA_{max} = \{5504.20;\ 6938.65;\ 0;\ 0;\ 6938.65;\ 0;\ 0\}$ stated in 2018 AU\$.

The income test thresholds for base and maximum payments, $TH_{base}$and TH_{max}, are

$$\begin{cases} TH_{max} & = FTBA_{T_1} \\ TH_{base} & = FTBA_{T_2} + (ndep_{[0,24],j} - 1) \times FTBA_{T_2A} \end{cases} \tag{A.3}$$

The maximum threshold is fixed while the base threshold expands at the rate of $FTBA_{T_2A}$ for every addition of a dependent child.

In 2018, the starting income test thresholds $FTBA_T = \{52,706;\ 94,316\}$, and the base payment income test threshold adjustment factor per additional qualifying child $FTBA_{T_2A} = 0$,all stated in 2018 AU\$.

We can then calculate the FTB A benefit.

$$FTBA_j^0(y_{\tau,hh}) = \begin{cases} m_{A,j} & \text{if } y_{\tau,hh} \leq TH_{max} \\ MAX\{b_{A,j},\, m_{A,j} - FTBA_{w_1}(y_{\tau,hh} - TH_{max})\} & \text{if } TH_{max} < y_{\tau,hh} \leq TH_{base} \\ MAX\{0, & \text{if } y_{\tau,hh} > TH_{base} \\ \qquad m_{A,j} - FTBA_{w_1}(y_{\tau,hh} - TH_{max}) & \\ \qquad b_{A,j} - FTBA_{w_2}(y_{\tau,hh} - TH_{base})\} & \end{cases} \tag{A.4}$$

Where the total household taxable income $y_{\tau,hh} = y_{\tau,h} + y_{\tau,w} + ra$ and $FTBA_w$ is the withdrawal rate. In 2018, $FTBA_w = \{0.20,\, 0.30\}$.

The statutory rates include extra supplement for low income households. In our calculation, this supplement is later deducted from the total benefit payment if a household does not meet the supplement's income test cutoff. The income test is conducted separately once the full benefit has been computed

$$FTBA_j(y_{\tau,hh}) = \begin{cases} MAX\{0,\; FTBA_j^0(y_{\tau,hh}) - FTBA_{AS} \times (ndep_{[0,12],j} & \text{if } y_{\tau,hh} > FTBA_{FT1} \\ \qquad\qquad +ndep_{[13,15],j} + \mathbf{1}_{\{school=1\}} ndep_{[1619],j})\} & \\ FTBA_j^0(y_{\tau,hh}) & otherwise \end{cases} \tag{A.5}$$

Where in 2018, the annual FTB A supplement adjustment $FTBA_{AS} = 737.30$ and the supplement's income test threshold $FTBA_{FT1} = 80,000$ stated in 2018 AU$.

Below are the formulae used to calculate the LFS, NBS, MBA, CES (for part A and part B), and RA in the model.

Large Family Supplement (LFS):

$$LFS_j = min\{FTBA_{S_1} \times (ndep_{[0,24],j} - FTBA_{C_1} + 1),\; 0\} \tag{A.6}$$

Where $ndep_{[a,b],j}$ denotes the number of children in the age range $[a,b]$ of parents aged j, $FTBA_{S_1}$is the LFS amount per child, and $FTBA_{C_1}$is the number of dependent children a family must have to be eligible for the LFS for the first child to satisfy the cutoff $FTBA_{C_1}$ and every additional child onward. In 2018, $FTBA_{C_1} = 1$ and $FTBA_{S_1} = 0$. **Newborn Supplement (NBS):**

$$NBS_j = \begin{cases} \mathbf{1}_{\{nb_j \geq 1,\; fc_j=1\}} FTBA_{NS_1} \times nb_j + \mathbf{1}_{\{nb_j \geq 1,\; fc_j=0\}} FTBA_{NS_2} \times nb_j & \textbf{if } ppl = 0 \\ \mathbf{1}_{\{nb_j \geq 2,\; fc_j=1\}} FTBA_{NS_1} \times (nb_j - 1) + \mathbf{1}_{\{nb_j \geq 2,\; fc_j=0\}} FTBA_{NS_2} \times (nb_j - 1) & \textbf{if } ppl = 1 \end{cases} \tag{A.7}$$

Where nb_j denotes the number of newborns to parents aged j, fc_j is a binary variable for first child, *ppl* is a binary variable for Paid Parental Leave (by default, we set *ppl* = 0), and $FTBA_{NS}$ is the amount of NBS per qualified child. In 2018, $FTBA_{NS} = \{2,158.89;\, 1,080.54\}$ stated in 2018 AU$.

Multiple Birth Allowance (MBA):

$$MBA_j = \begin{cases} \mathbf{1}_{\{sa=3,\ j_c \leq FTBA_{MAGES}\}} FTBA_{MBA_1} + \mathbf{1}_{\{sa \geq 4,\ j_c \leq FTBA_{MAGES}\}} FTBA_{MBA_2} & \text{if } school = 1 \\ \mathbf{1}_{\{sa=3,\ j_c \leq FTBA_{MAGE}\}} FTBA_{MBA_1} + \mathbf{1}_{\{sa \geq 4,\ j_c \leq FTBA_{MAGE}\}} FTBA_{MBA_2} & \text{if } school = 0 \end{cases} \tag{A.8}$$

Where sa is the number of dependent children with the same age, $school$ is a binary variable for school attendance, j_c is the age of children sharing birth date, and $FTBA_{MAGE}$ and $FTBA_{MAGES}$ are a child's age cutoffs to be eligible for the MBA if they attend and do not attend school, respectively. $FTBA_{MBA}$ is the MBA payment. For simplicity, we assume there can only be one instance of multiple births for each household.

In 2018, $FTBA_{MAGE} = 16$, $FTBA_{MAGES} = 18$, and $FTBA_{MBA} = \{4,044.20;\ 5,387.40\}$ stated in 2018 AU$.

Clean Energy Supplement for the FTB part A ($\mathbf{CES_A}$): The Clean Energy Supplement for the FTB part A ($\mathrm{CES_A}$) is separated into base and maximum payments. We add the former to the base level and the latter to the maximum level of the FTB A benefit.

$$CES_{A,base,j} = ndep_{[0,17],j} \times FTBA_{CE_1} + ndep_{[18,19]_{AS},j} \times FTBA_{CE_1} \tag{A.9}$$

$$CES_{A,max,j} = ndep_{[0,12],j} \times FTBA_{CE_2} + ndep_{[13,15],j} \times FTBA_{CE_3} + ndep_{[16,19]_{AS},j} \times FTBA_{CE_3} \tag{A.10}$$

where $ndep_{[a,b],j}$ denotes the number of children in the age range $[a, b]$ of parents aged j, $school$ is a binary variable for school attendance, $ndep_{[a,b]_{AS},j} = \mathbf{1}_{\{school=1\}} \times ndep_{[a,b],j}$, $FTBA_{CE}$ is the per child amount of the CES_A. In 2018, $FTBA_{CE} = \{36.50;\ 91.25;\ 116.80\}$ in 2018 AU$.

Note that from 2018 onward, only households who had received the CES_A in the previous year were eligible for the supplement. In the baseline model, we assume this is true for all households.

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.

$$RA_j(rent) = \begin{cases} MAX\{MIN\{0.75\,(rent - rent_{min}),\ RA_{max}\},\ 0\} & \text{if } FTBA_1 \geq FTBA_{min} \\ 0 & \text{otherwise} \end{cases} \tag{A.11}$$

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.1.2 FTB-A means-test parameters and related income statistics

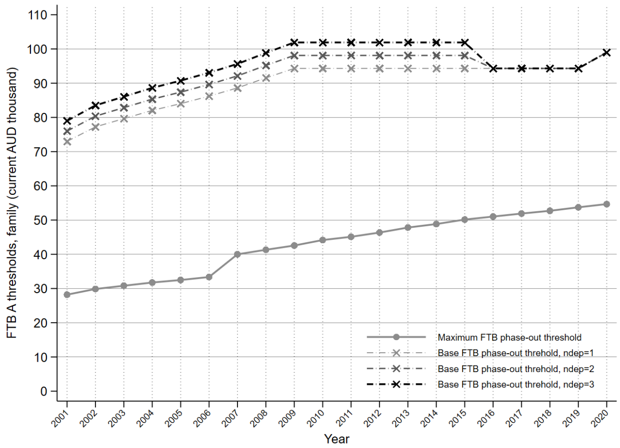

Figure A.1: FTB-A income test thresholds for maximum and base payment rates

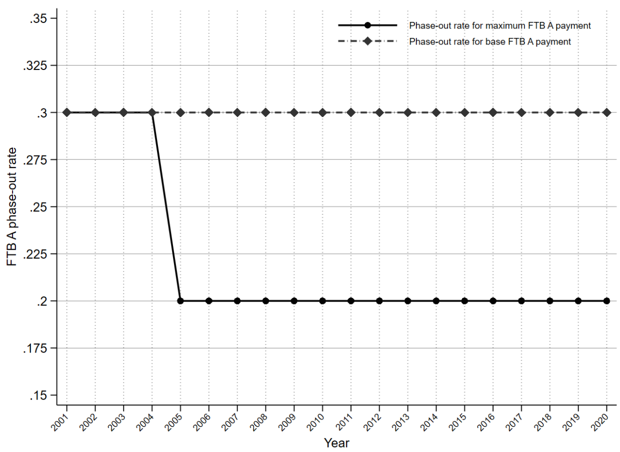

Figure A.2: FTB-A taper/phase-out rates for maximum and base payments

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

A.2.1 Program description and formulae

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)

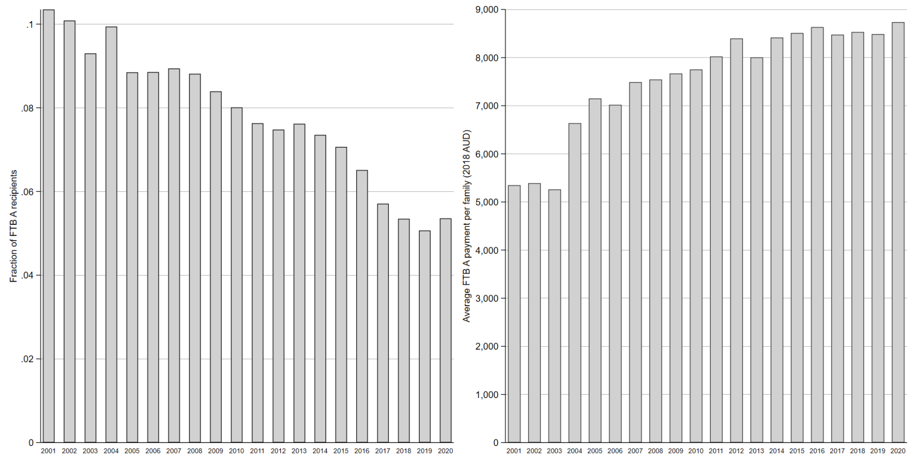

Figure A.3: **Fractions of FTB-A recipients and average FTB-A payment per family (2018 AUD) over time.**

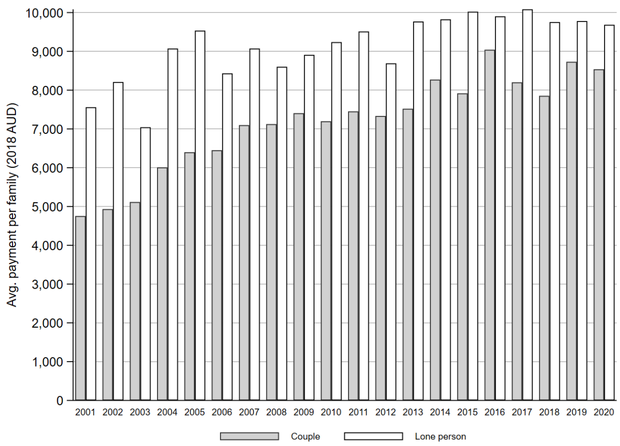

Figure A.4: Average FTB-A payment per family by marital status

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

$$FTBB_j(y_{\tau,h}, y_{\tau,w}) = \begin{cases} cond_1 \times m_{B_1,j} + cond_2 \times m_{B_2,j} & \text{if } y_{pe} \leq FTBB_{T_1} \text{and } y_{se} \leq FTBB_{T_2} \\ \\ cond_1 \times MAX\{0,\ m_{B_1,j} - FTBB_w(y_{se} - FTBB_{T_2})\} & \text{if } y_{pe} \leq FTBB_{T_1} \text{and } y_{se} > FTBB_{T_2} \\ +cond_2 \times MAX\{0,\ m_{B_2,j} - FTBB_w(y_{se} - FTBB_{T_2})\} \end{cases} \tag{A.12}$$

From 2017

$$FTBB_j(y_{\tau,h}, y_{\tau,w}) = \begin{cases} cond_1 \times m_{B_1,j} + cond_3 \times m_{B_2,j} & \text{if } y_{pe} \leq FTBB_{T_1} \text{and } y_{se} \leq FTBB_{T_2} \\ \\ cond_1 \times MAX\{0,\ m_{B_1,j} - FTBB_w(y_{se} - FTBB_{T_2})\} & \text{if } y_{pe} \leq FTBB_{T_1} \text{and } y_{se} > FTBB_{T_2} \\ +cond_3 \times MAX\{0,\ m_{B_2,j} - FTBB_w(y_{se} - FTBB_{T_2})\} \end{cases} \tag{A.13}$$

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

In 2018, the statutory maximum FTB B payment $FTBB_{max} = \{4,412.85;\ 3,190.10\}$, the income test thresholds $FTBB_T = \{100,000;\ 5,548\}$ in 2018 AU\$, and the withdrawal rate $FTBB_w = 0.20$.

Clean Energy Supplement for the FTB part B ($\mathbf{CES_B}$): The Clean Energy Supplement for FTB part B ($\mathrm{CES_B}$) adds to the statutory per family payment of the FTB B benefit.

$$CES_{B,j} = \begin{cases} FTBB_{CE_1} & \text{if } ndep_{[0,4],j} \geq 1 \\ FTBB_{CE_2} & \text{if } ndep_{[0,4],j} = 0 \text{ and } (ndep_{[5,15],j} \geq 1 \text{ or } ndep_{[16,18]_{AS},j} \geq 1) \\ 0 & \text{if } ndep_{[0,4],j} = 0 \text{ and } ndep_{[5,15],j} = 0 \text{ and } ndep_{[16,18]_{AS},j} = 0) \end{cases} \tag{A.14}$$

where $ndep_{[a,b],j}$ denotes the number of children in the age range $[a, b]$ of parents aged j, $school$ is a binary variable for school attendance, $ndep_{[a,b]_{AS},j} = \mathbf{1}_{\{school=1\}} \times ndep_{[a,b],j}$, $FTBB_{CE}$ is the per family amount of CES_B. In 2018, $FTBB_{CE} = \{73;\ 51.10\}$ in 2018 AU\$.

Note that from 2018 onward, only households who had received the CES_B in the previous year were eligible for the supplement. In the baseline model, we assume this is true for all households.

A.2.2 FTB-B means-test parameters and related statistics

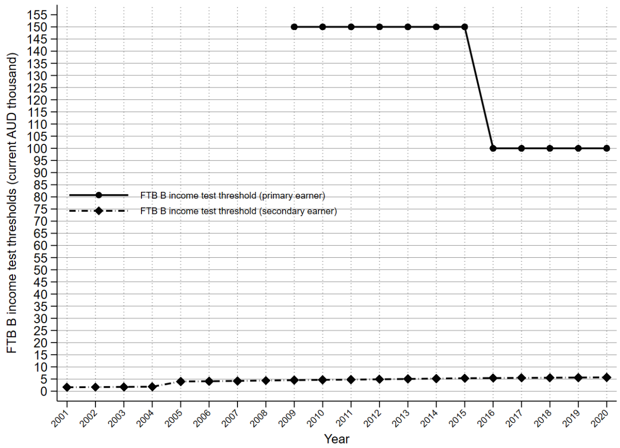

Figure A.5: **FTB-B thresholds over time on primary and secondary earners over time.**

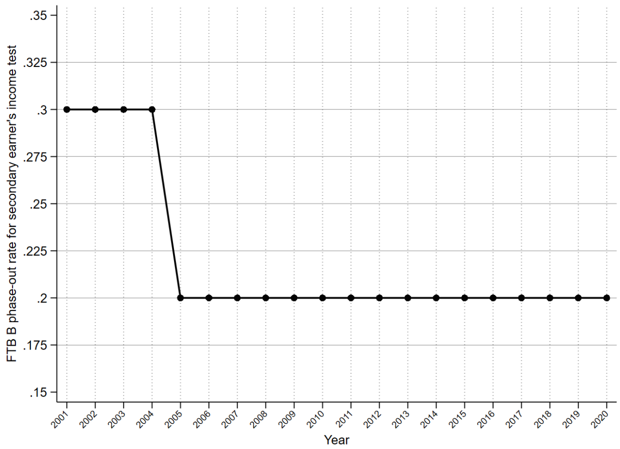

Figure A.6: **FTB-B taper rates over time.**

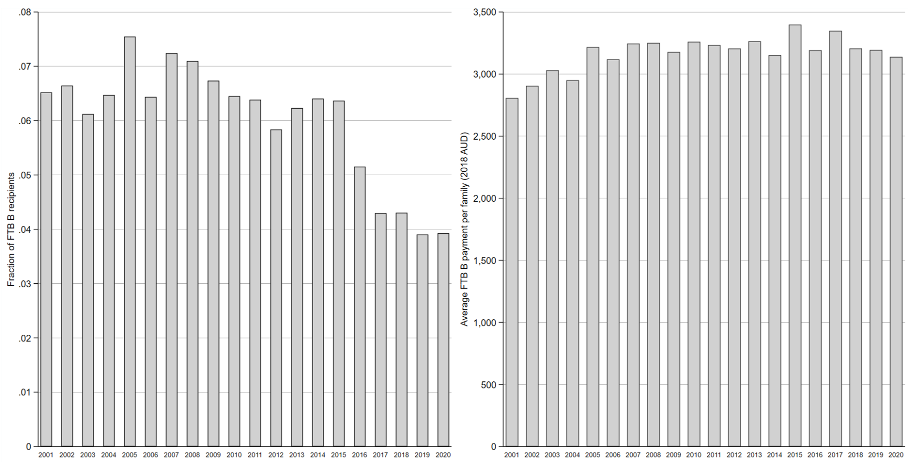

Figure A.7: **Fractions of FTB-B recipients and average FTB-B payment per family (2018 AUD) over time.**

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,[41]
3. Households exhaust all the available hours of subsidized care.

The child care subsidy function is

$$CCS(y_{\tau,hh}, n_j^h, n_j^w) = \Psi(y_{\tau,hh}, n_j^h, n_j^w) \times \begin{cases} CCS_{R_1} & \text{if } y_{\tau,hh} \leq TH_1 \\ MAX\{CCS_{R_2},\ CCS_{R_1} - \omega_1\} & \text{if } TH_1 < y_{\tau,hh} < TH_2 \\ CCS_{R_2} & \text{if } TH_2 \leq y_{\tau,hh} < TH_3 \\ MAX\{CCS_{R_3},\ CCS_{R_2} - \omega_3\} & \text{if } TH_3 \leq y_{\tau,hh} < TH_4 \\ CCS_{R_3} & \text{if } TH_4 \leq y_{\tau,hh} < TH_5 \\ CCS_{R_4} & \text{if } y_{\tau,hh} \geq TH_5 \end{cases} \tag{A.15}$$

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

A.4 More on the parametric tax function 11

We divide Y of 11 by the income level Y_Q associated with the Q^{th} quantile of interest.

[41] 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.

$$T_{Y_Q} = T\left(\frac{Y}{Y_Q}\right) \quad = \quad \frac{Y}{Y_Q} - \zeta\left(\frac{Y}{Y_Q}\right)^{1-\tau}$$

When $Y = Y_Q$, this implies

$$T_{Y_Q} \quad = \quad 1 - \zeta \qquad \text{(A.16)}$$

The estimated $1 - \zeta$ is therefore the tax paid by households at the Q^{th} quantile of the income distribution.

A.5 Additional data and empirical facts

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.

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 A.2: **Summary statistics of primary earners in financial year 2020**. The values of income, tax liabilities and transfers are expressed in 2018 AUD.

Fact 1: Child-related transfers are important sources of income for low income households. Table A.3 and Figure A.8 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 A.4 suggests that even among parents, the family transfer design places emphasis on marital status to account for equivalence scale of consumption (i.e., consumption economies of scale for larger size households). Among the recipients, single households get about as much benefit as married households do.

The annual family transfer benefits for parents are substantial up to the median quintile. One could argue that the disincentive effect extends to the middle income, though the magnitude of the effect might be small. What the statistics here imply is that an attempt to flatten the taper rates for the poor might cause leak the high participation tax rate problem further into the middle-income bracket.

		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 A.3: **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.**

Fact 2: Distinct shapes of the life-cycle labor supply of mothers

Fact 3: There are big gaps in wages and earnings between parents and non-parents Based on Figure A.11, 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 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.,

			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 A.4: **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.**

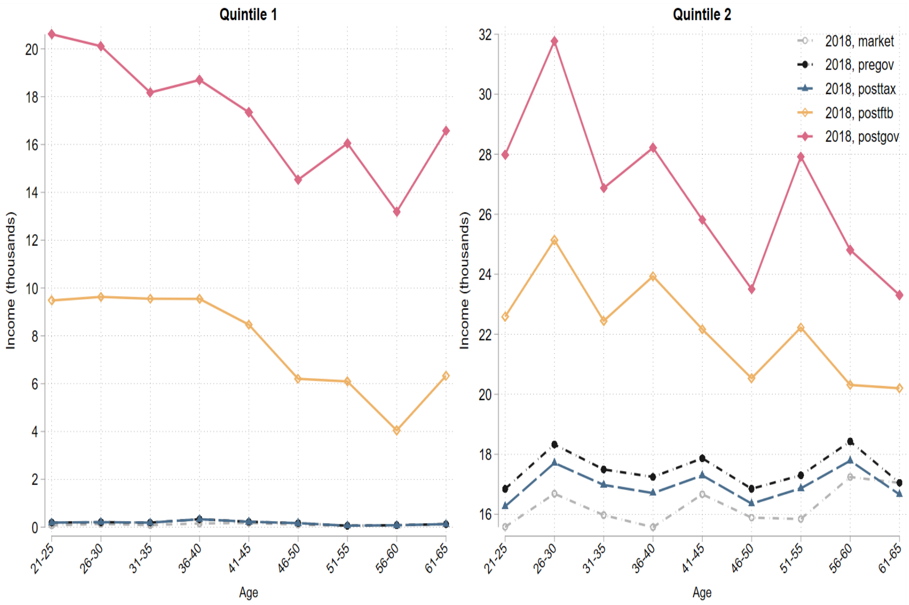

Figure A.8: **Age profiles of income at different levels for parents in the bottom two quintiles of pre-government income.**
Notes: Pre-government income (black line) is a combined income from all market sources and private transfer before tax and public transfer. Post-tax income (blue line) is pre-government 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.

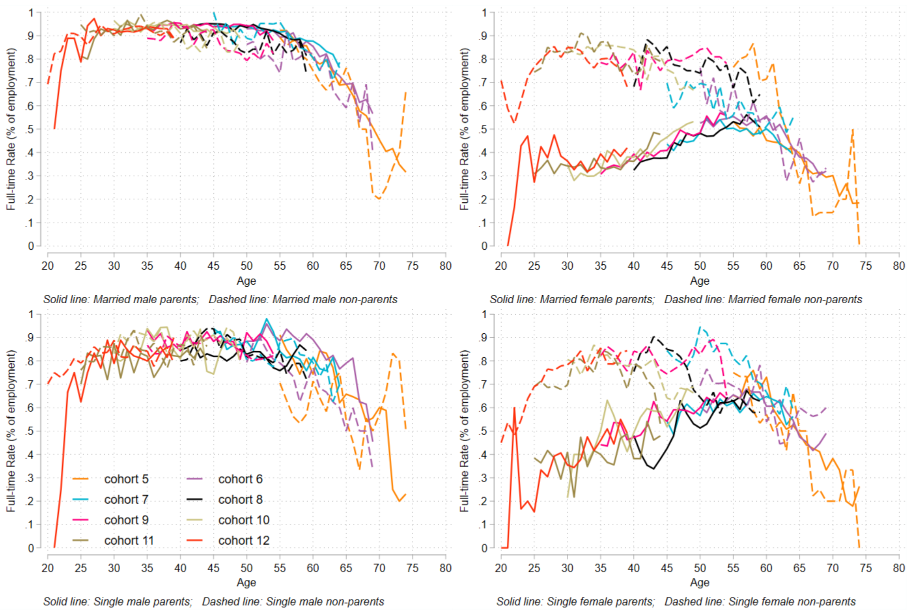

Figure A.9: **Age profiles of full-time share of employment by key demographics (gender, marital status and parenthood). Top left:** married fathers (solid) and married childless men (dashed). **Top right:** married mothers (solid) and married childless women (dashed). **Bottom left:** single fathers (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.

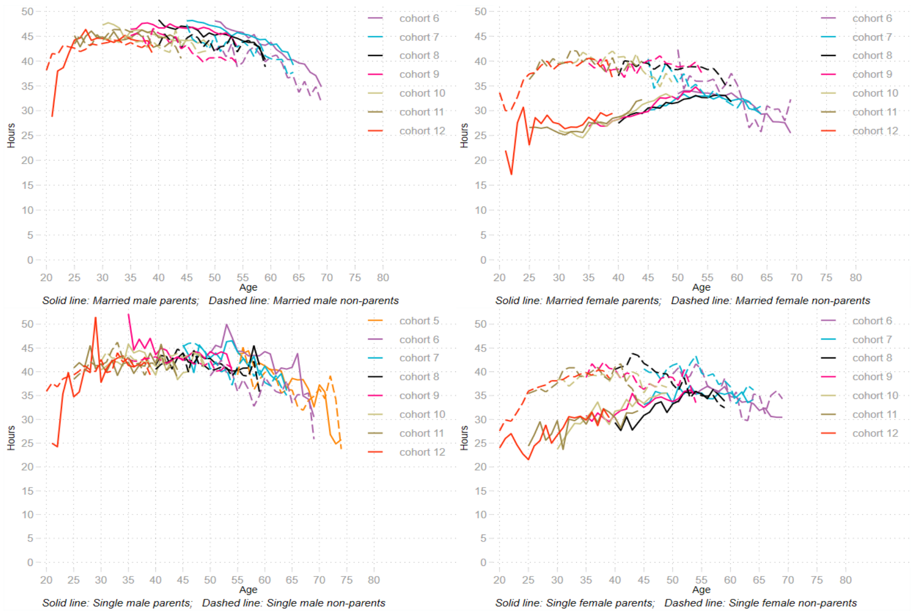

Figure A.10: **Age profiles of work hours (if employed) by key demographics (gender, marital status and parenthood). Top left:** married fathers (solid) and married childless men (dashed). **Top right:** married mothers (solid) and married childless women (dashed). **Bottom left:** single fathers (solid) 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).

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.

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);
   - 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

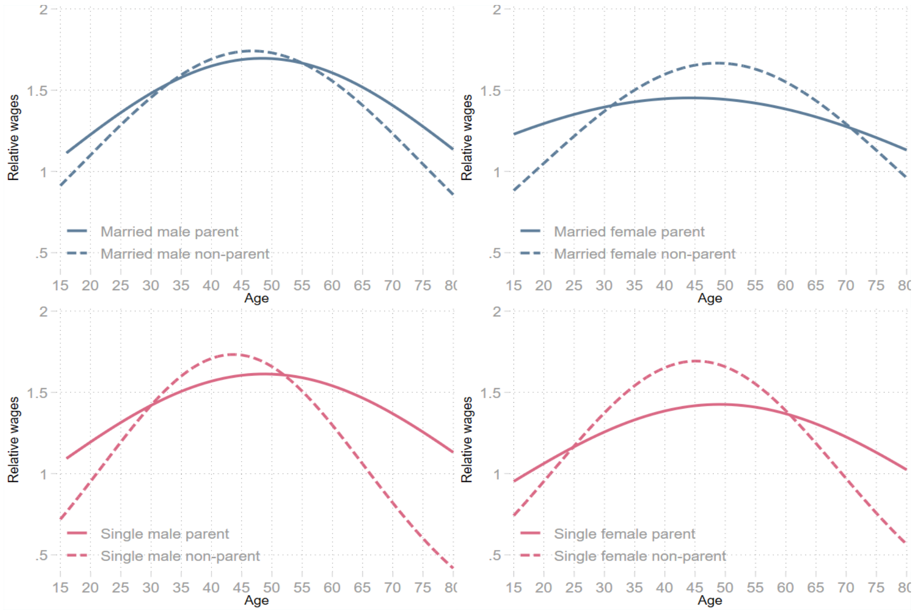

Figure A.11: **Age profiles of normalized wages (against age-21 worker's average wages) by key demographics (gender, marital status and parenthood). Top left:** married fathers (solid) and married childless men (dashed). **Top right:** married mothers (solid) and married childless women (dashed). **Bottom 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.

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;[42]
    - $h^f_{max,\lambda=0,\ell} = h^m_{max,\lambda=0,\ell}$ 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;

[42] 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.

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 $\{a_j^+, c_j, \ell_j\}_{j=1}^J$;
   - the time-invariant survival probabilities $\{\psi\}_{j=1}^J$;
   - the Markov transition probabilities of the transitory earnings shocks η;
   - the law of motion of female human capital from equation 6;

   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.

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 $B_{F,t} = A_t - K_t - B_t$ 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).[43]

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.

[43] 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 Additional Tables and Figures

C.1 Tables

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.1: **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.2: **Welfare expenditure to GDP (%) by target groups**

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

C.2 Figures

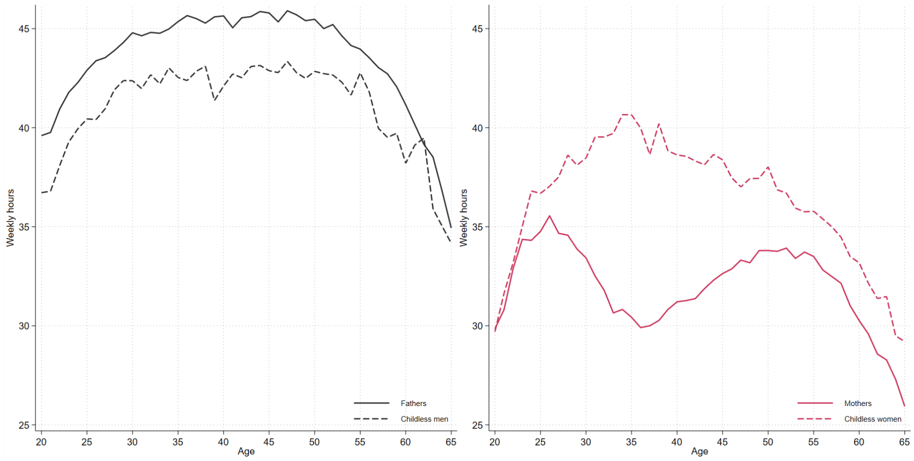

Figure C.1: Intensive margin: Age profiles of work hours (if employed) by key demographics (gender and parenthood). Left: fathers (solid) and childless men (dashed). Right: mothers (solid) and childless women (dashed).

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 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.

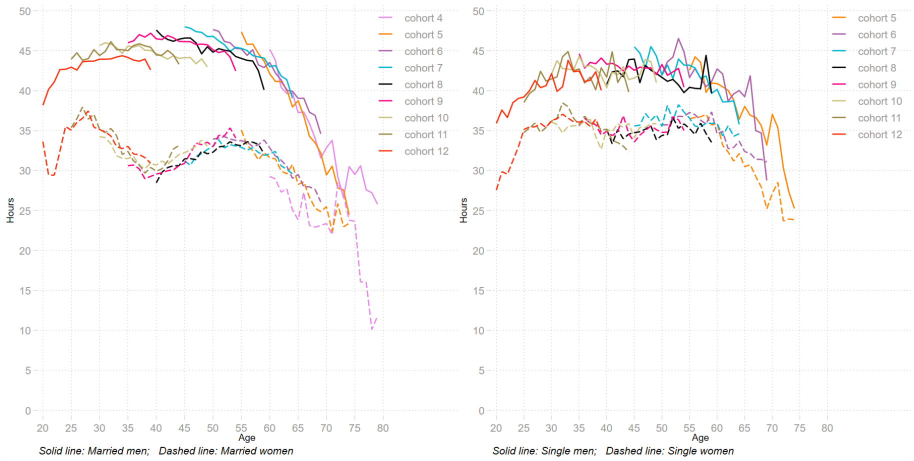

Figure C.2: Intensive margin: Age profiles of work hours (if employed) by marital status and gender. Left panel: married men (solid line) and married women (dashed line). Right panel: single men (solid line) and single women (dashed line).
Notes: The age profiles stitch together 20-year snapshots of 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.

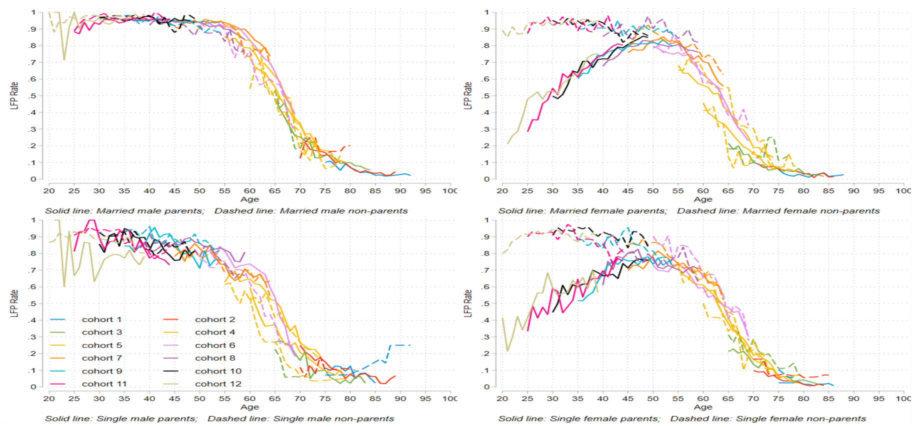

Figure C.3: **Extensive margin: Age profiles of labor force participation by key demographics (gender, marital status and parenthood). Top left:** married fathers (solid) and married childless men (dashed). **Top right:** married mothers (solid) and married childless women (dashed). **Bottom left:** 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.

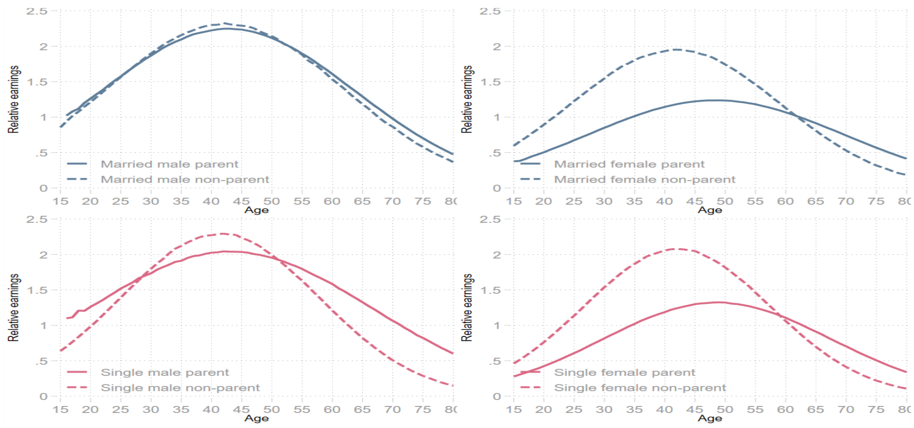

Figure C.4: **Age profiles of normalized weekly earnings (against age-21 worker's average earnings) by key demographics (gender, marital status and parenthood). Top left:** married fathers (solid) and married childless men (dashed). **Top right:** married mothers (solid) and married childless women (dashed). **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.