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 joint family income tests determine eligibility and benefit levels of child-related transfers. We first document key empirical facts on child-related transfers and distinct age-profiles of labor supply of mothers in Australia, using household survey data HILDA 2001-2020. Next, we build a dynamic general equilibrium overlapping generations model of single and married households with children and quantify the implications of child-related transfers with means testing for female labor supply, macro aggregates, and welfare. Our results indicate that strict and complex means testing rules can result in significant adverse effects on female labor supply and human capital accumulation. A reform that switches from the benchmark means-tested child-related transfer system to a universal system can improve aggregate efficiency and overall welfare. This reform is supported by the majority; however, it leads to welfare losses of single mothers who are the intended beneficiaries.

JEL: E62, H24, H31

Keywords: Child-Related Transfers; Means-Testing; 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. Child-related transfers, including child care subsidies, child tax credits, and lump-sum transfers are either universal or means-tested, and subject to conditions related to the number of children or work status.

In practice, OECD countries have adopted different approaches to means testing of child-related transfers. Australia, in particular, has a long history of implementing a means-tested child-related transfer system with the following distinct features: (i) direct lump-sum child benefits independent of labor force status and formal child care cost subsidy for working parents; and (ii) joint (family) income test as the central policy tool used 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 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 result in significant work disincentives. For this reason, the question of how to design an optimal child-related transfer program has 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 life cycle statistics using household survey data HILDA 2001-2020. We highlight three key empirical facts: (i) child-related transfers are important sources of income for low income households; (ii) life cycle labor supply profiles of mothers have distinct features, such as the peculiar M-shaped full-time employment share profile, which set them apart from men and childless women; and (iii) there are large earnings discrepancies between mothers and non-mothers.

Next, we formulate a simple model to highlight how the inclusion of means testing into a child-related transfer program affects labor supply decision of a family with children. We then develop a full dynamic general equilibrium overlapping generations (OLG) model of single and married households who face income and longevity risks, time and monetary costs of raising children, and unequal access to child-related transfers due to means testing to explore the questions quantitatively. Our modeled households are heterogeneous in terms of marital and parental status, number 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 their life cycles. There are two major government transfer programs that support households with 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.

We use the calibrated model to quantify the long-run implications of means-tested child-related

[1] Australia has been running a child-related transfer system with means testing 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 also introduced income test to phase out child tax credits for high income families according to the American Rescue Plan Act 2021.

transfers for female labor supply, macro aggregates, and welfare by conducting a series of counterfactual analyses accounting for both incremental and radical reforms to the child-related transfer schemes. In each counterfactual consideration, we vary policy parameters related to one or both of the programs and use income tax as a budget-balancing variable, while holding other policy parameters, government debt, and general expenditure (net of child-related transfers and age pension) at their initial steady state levels. Our main results are summarized as follows.

In our first set of experiments, we compare steady state results between the benchmark and the counterfactual economies in which we abolish either (i) the FTB, (ii) the CCS, or (iii) all child-related transfers. The first and third experiments generate output gains from higher workforce participation and human capital of mothers at the cost of welfare losses. The third experiment, by eliminating both programs, leads to significant efficiency gains with a relatively small welfare loss. However, the adverse welfare consequence disproportionately affects single mothers who have no family insurance and whose ability to self-insure against future earnings and thus consumption risks is limited by the pecuniary and non-pecuniary penalties of child care. Eliminating the CCS, the second experiment, is a lose-lose policy. Since the subsidy supports the act of self-insurance, the new CCS-free economy experiences large reductions in labor supply and human capital. This consequently enlarges the FTB program, which in turn imposes a large tax burden that offsets the initial tax alleviation effect of the CCS removal. That is, the FTB transfer is fulfilling its government insurance role, but its positive welfare effect is outweighed by the depressed disposable earnings for the average household. Ultimately, the reform leads to a moderate welfare loss. These results emphasize the trade-offs between efficiency and welfare. Overall, the negative welfare effects from removing either one or both child-related transfer programs are dominants. We conclude that child-related transfers are socially desirable based on the welfare perspective in our framework.

We then turn to the question of whether the status quo means-tested child-related transfers, as a mechanism to deliver child benefits, can deliver better welfare outcomes than a universal system design. We find means-testing that restricts the beneficiaries to low income households can have significant disincentive effects on work effort and human capital accumulation due to the resultant higher effective marginal tax rates (EMTRs). A reform that switches from the benchmark means-testing to a universal system can be both efficiency and welfare improving. This reform is supported by the majority. However, the aggregate effects can mask the significant welfare redistribution underneath. First, our results indicate that while the universal system removes all the downsides of means-testing, it loses the ability to restrain the fiscal costs. Universal transfers at the benchmark FTB and CCS payment rates can significantly increase the total size of the programs. Second, because the maximum transfers only last for a short period when children are young, we find that universal child-related transfers cannot replace the income and human capital accumulation earned through work for single mothers. Hence, the substantial tax burden resulting from this radical reform ultimately diminishes the welfare of single mothers, who are the intended beneficiaries and rely on labor earnings.

Last, we extend our analysis to cover selected cases of incremental reforms to the means-test parameters. In particular, we consider changes to the transfer payment/subsidy rates and the taper rates. Our findings demonstrate that most of the new regimes involve efficiency and welfare trade-offs. The single exception is when the CCS taper rates are relaxed (halved). Compared to the universal scheme, this generates an overall efficiency gain and moderate welfare benefits for all households. Conversely, the aggregate welfare gain is smaller and married households, who constitute the majority, benefit less relative to what the universal regime has to offer. Thus, a more incremental reform could lead to a small but more equitable gain; meanwhile, the universal child-related transfers at the benchmark payment and subsidy rates would still secure the most votes if both policy options were presented.

Related literature. This paper is related to a strand of literature focusing 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 implications of taxation for the cross-country married men's and women's work hour differences across 17 European countries and the US. Recent developments also focus on 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 a first study of the Australian case where income is taxed separately while child-related transfers are strictly means-tested on joint income and largely independent of work. In terms of methodology, we extend the model in Guner, Kaygusuz and Ventura 2020 to have both earnings and mortality risks for male and female. We also consider a large set of experiments on different designs of the child-related transfer scheme.

Our paper also contributes to another related literature focusing 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 results suggest that means-testing distorts incentives to work and save, but can be useful for balancing the insurance and incentive trade-offs, which results in overall welfare improving. We extend the literature and demonstrate a similar mechanism at work for government transfers to families with children. At the same time, we show that the universal system can be an overall improvement to the means-testing transfers and win the majority vote, but it can also conceal undesirable redistributive effects that contradict 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 presents a simple model to build economic intuitions. Section 4 gives a full description of the dynamic general equilibrium model. Section 5 reports the internal and external calibration procedures, and the performance of the benchmark economy. Section 6 discusses selected counterfactual analyses. Section 7 concludes. The Appendix provides additional results and descriptive statistics, detailed information on the two child-related transfer programs, and the computational algorithm to solve the model.

2 Child-related transfers in Australia

In this section, we provide brief institutional features of the two child-related transfer programs and selected empirical life cycle facts of Australian individuals and households that we document using data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey Restricted Release 20 (2001 – 2020). 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 22.5 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 flexible payment rates and income test thresholds, adjusted 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 programs 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 depend on labor market participation and consists of two parts. The FTB part A (FTB-A) tests joint income. Its maximum and base payments per child 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.

On the other hand, the CCS program subsidizes the cost of formal child care services, including out of school hours care (OSHC), for children up to 13 years old, based on means testing joint family income. A distinctive feature of the CCS, setting it apart from the FTB, is its activity test on the secondary earner's work hours to adjust the rate of subsidy. 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 total formal child care costs. Thus, 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.

Appendix A gives a comprehensive breakdown of the two programs, 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. For this subsection, enabled by the availability of data on the FTB parameters and its recipients, we delve into the FTB's evolution over the past two recent decades.

The FTB-A over time

The FTB-A alone represents a significant sum of transfer (indexed to inflation). Despite the intricacy, the left and right panels of Figure 1 illustrate that there have not been much change to the base and maximum payment rates for children under 18. Since 2004, families with a child aged 1315 that qualified for the maximum payment could receive up to $7,000 in 2018 AUD. Given that payments are allocated per child, an average family with two children in this age bracket could potentially receive up to $14,000. Moreover, while the maximum rate for children aged 12 or younger is lower, it is still a considerable amount, exceeding $5,500 per child.

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

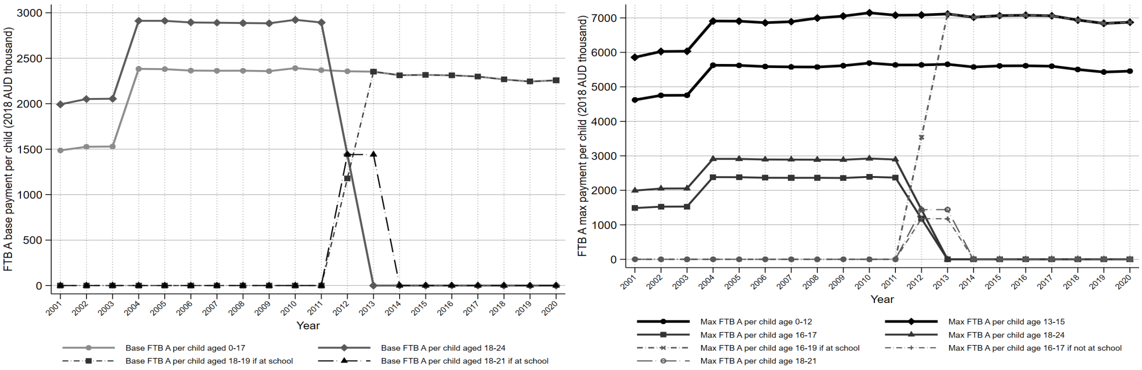

Figure 1: **Base and maximum FTB-A payment rates per qualified child**

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. This extensive margin decline can be attributed, in part, to inflation and the falling birth rate. Meanwhile, the intensive margin has been rising.[3] 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, and scales based on the number of children, we observe that single parent households claimed more benefits on average compared to partnered parent households (Figure A.4).

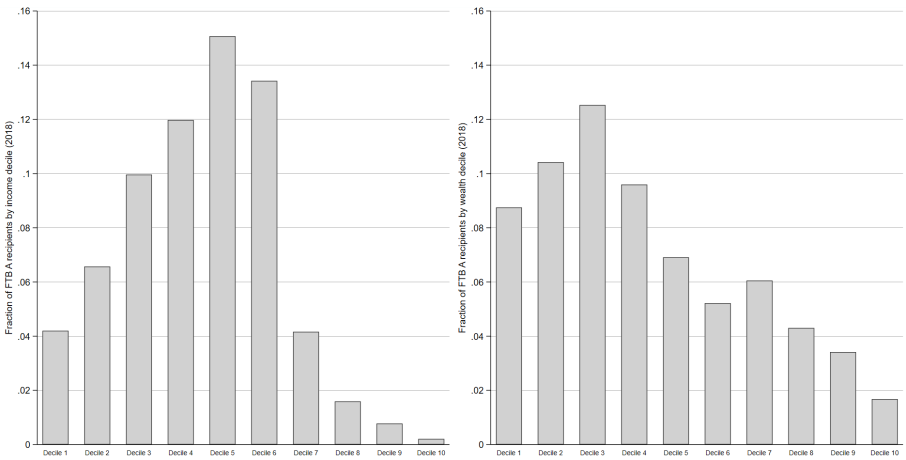

Figure 2: **Fractions of FTB-A recipients in 2018 by income and wealth deciles.**

It is worth highlighting that due to the lack of assets test, relatively wealthy households in 2018 were able to benefit from the scheme, as demonstrated in Figure 2.[4] The left panel also reveals that the FTB-A benefit still extends to families around the median income in spite of means-testing joint income. This inevitably raises the EMTRs and potentially results in a low or lower-middle income trap if the payment is large enough to influence behavior. That said, Figure 5 in the next subsection on life

[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).

[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.

cycle facts indicates that the share of FTB-A and FTB-B combined is inconsequential for those in the third income quintile. Based on the fact presented, one could argue that reducing the current FTB might not impact beyond the second income quintile. However, expanding the FTB could intensify the average benefit for the upper income households. This could affect work incentive and thus make for a different narrative.

The FTB-B over time

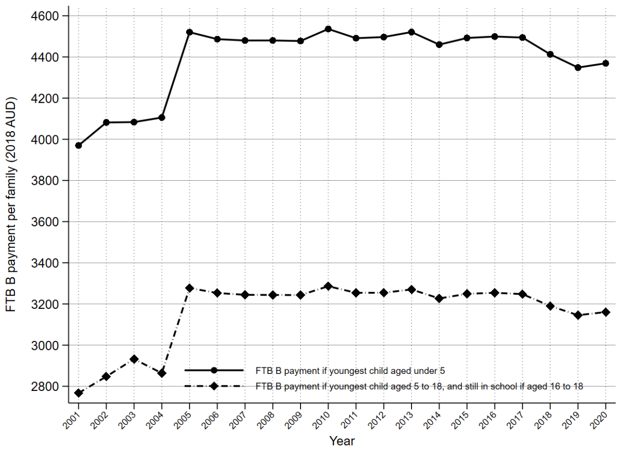

Figure 3: **FTB-B payment rates per family by age of the youngest child in the family**

The goal of the FTB-B is to give extra support to single parents and single-earner couple parents, and is rewarded to households with positive FTB-A benefit. Figure A.3 in the Appendix and Figure 4 therefore imply that the majority of FTB-A households claimed FTB-B. Moreover, even though the FTB-A is the larger of the two FTB components, the FTB-B still offers a non-trivial lump sum to families. Figure 3 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 for those with their youngest child aged between 5 and 18.

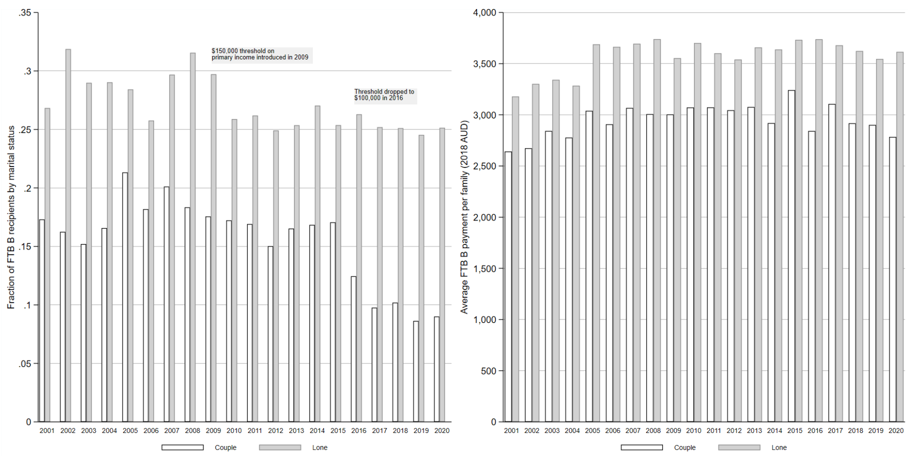

Figure 4: **Fractions of FTB-B recipients and average FTB-B payment per family by marital status.**

Compared to figures from the 2000s and first half of 2010s, the fraction of partnered FTB-B households plummeted by nearly 50% by 2020 (see the left panel Figure 4). Factors such as fertility trends and inflation partially explain this decline, and for the FTB-B in particular, the recent decline in recipients among couples was driven partly by the decline in the fraction of FTB-A recipients as implied by Figure A.3. This development can 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 dropped to $100,000. These stricter measures, complementing the existing test on secondary earners, reduced the claimant pool. However, because the primary earner's income test exclusively determines eligibility (thus controlling only the extensive margin), we see no discernible effect on the payment rate. The right panel of Figure 4 shows that, on average, 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 per family — similar to amounts they would receive from 2005.

2.2 Empirical life cycle facts

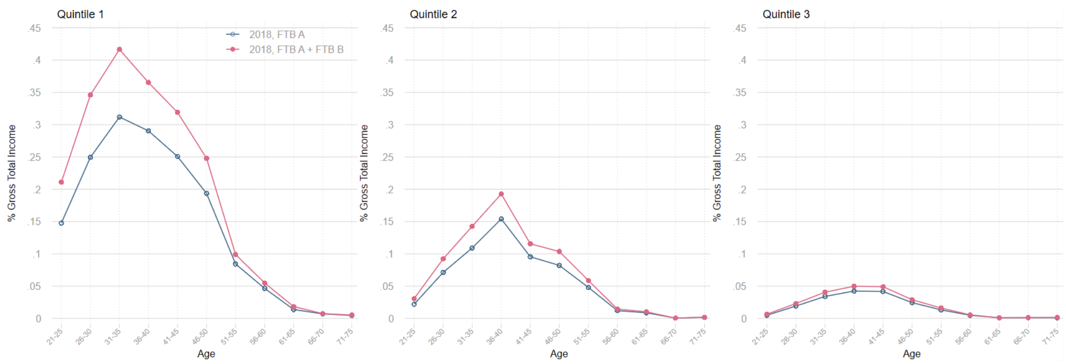

Figure 5: **Age profiles of FTB share of gross total household income for the first three quintiles by joint market earnings in 2018 for all households.**

Fact 1: Child-related transfers are important income sources. As shown in the preceding subsection, the average statutory and effective FTB payments have remained largely unchanged over the past two decades in spite of a decrease in the number of beneficiaries. Accompanying this fact is Figure A.8 which depicts the 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 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 benefits comprise 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.

Fact 2: Distinct age-profiles of labor supply of mothers. The presence of dependent children is associated with different life cycle profiles of labor force participation and full-time share of employment for both men and women.[5] As portrayed in Figure 6, a larger proportion of fathers participate in the workforce relative to their childless counterparts, a persistent trend throughout their life cycles.

[5]For our purpose, 'parents' are defined as individuals with dependent children in order to match with the definition of parents 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 (as in Figure C.3), makes the labor force participation gap between fathers and non-fathers negligible while that between mothers and non-mothers becoming even more apparent.

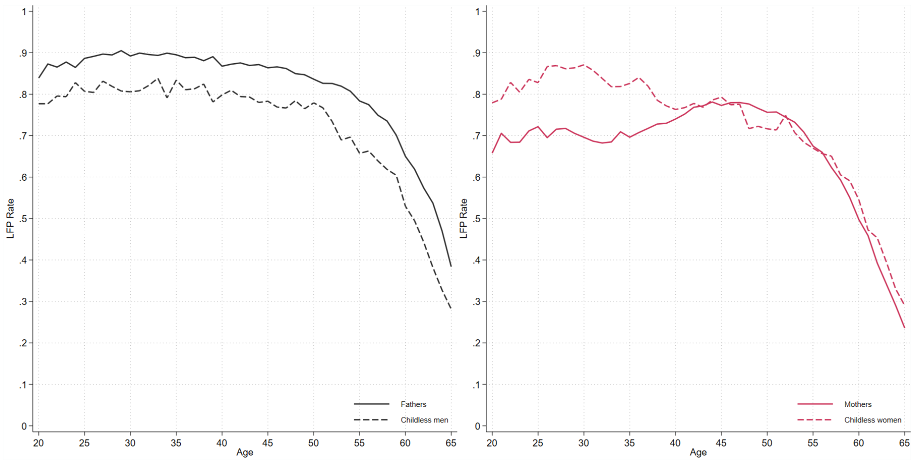

Figure 6: **Age profiles of labor force participation by key demographics (gender and parenthood). Left:** fathers (solid) and childless men (dashed). **Right:** mothers (solid) and childless women (dashed).
Notes: The age profiles stitch together 20-year snapshots of life cycle for selected cohorts. The youngest cohort is cohort 12 aged 20-39 in the data, and the oldest cohort is cohort 12 aged 75-94.

The puzzle, though, lies with the case of women. For the first 20 years or so of their adult lives, a smaller fraction of mothers participates in the workforce compared to childless women. Only 70% of young mothers are in the labor force and remain so until age 35. On the contrary, around 80% of childless women join the labor force early, peaking above 85% before declining right around age 30. This creates a 10*pp* gap between the two groups, widening in their early 30s and narrowing when both groups reach their early 40s, at which point their profiles merge and follow virtually the same path thereon.

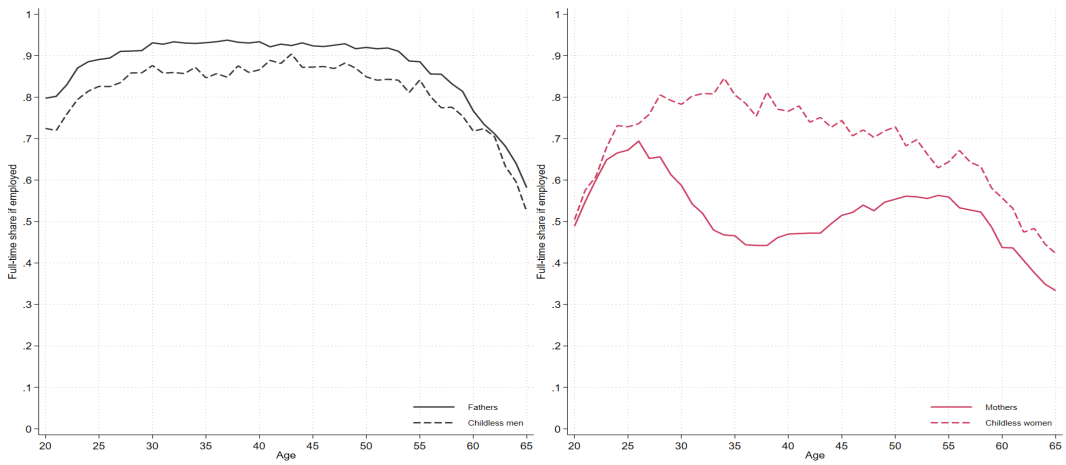

Figure 7: **Age profiles of full-time share of employment by key demographics (gender and parenthood). Left:** fathers (solid) and childless men (dashed). **Right:** mothers (solid) and childless women (dashed).

Figure 7 shows similar patterns for the life cycle profiles of full-time share of employment. The full-time shares of fathers and non-fathers mirror their labor force participation profiles. In contrast, the divergence between mothers and non-mothers is even more pronounced. Note that, although the full-time share profile of childless women remain below that of childless men, it exhibits a similar hump-shaped feature as men's. That of mothers, on the other hand, sketch a distinct M-shaped pattern. The largest divergence between mothers and non-mothers is between the ages of 3540. At this point, 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 fully closes. The gradual recovery is such that the proportion of mothers in full-time employment never reaches 60% and the gap between mothers and non-mothers remains at approximately 10*pp* by age 65. We observe similar evolution of parent and non-parent life cycle profiles of work hours based on Figure C.1 in the Appendix. The recession in the middle of working age that creates the distinct M-shaped work hour profile is mainly driven by the larger share of mothers in part-time employment. 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.

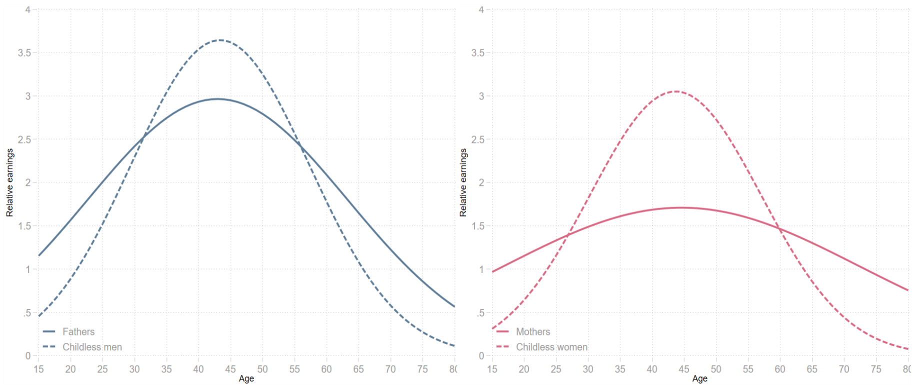

Figure 8: **Age profiles of normalized weekly earnings (against age-21 worker's average earnings) by key demographics (gender and parenthood). Left:** fathers (solid) and childless men (dashed). **Right:** mothers (solid) and childless women (dashed).
Notes: Due to the lack of balanced panel data covering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

Fact 3: Large earnings discrepancies between mothers and the rest of the group. Figure 8 reports the age-profiles of weekly earnings relative to the average earnings of a 21-year-old worker. Non-parents display comparable earnings trajectories over their life cycles. Regardless of gender, their earnings age profiles peak higher and exhibit flatter tails than those of parents. Childless women do tend to earn less than their male peers, especially in the middle of their working lives, but the greatest difference is between mothers and all the other non-mother groups. Given their reduced labor force participation and full-time share of employment, and limited hours worked throughout most of their prime working years, it is perhaps not surprising that by age 45, mothers' average weekly earnings amount to half of what non-mothers of the same age earn.[6]

3 A simple model

In this section, we formulate a simple theoretical model to highlight how the inclusion of means testing into a child-related transfer program can affect female labor supply decision of a family with children.

We consider a married couple with children. The husband has an inelastic labor supply and earns labor income (y^m); meanwhile, the labor supply of the wife $(1 - l^f)$ is flexible. Suppose that the wife's

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

earnings is always in a tax-free zone to simulate the benefit of individual filing and progressive tax system on female labor supply (see Kaygusuz 2010). In addition, suppose further that the wife also receives a wage subsidy at the rate s which represents the CCS. The household budget constraint is given by

$$c = \overbrace{(1 - l^f)(1 + s)w + (1 - \tau)y^m}^{\text{=family income after tax and subsidy}} + tr^{FTB},$$

where c is joint family consumption; τ is labor income tax; w is market wage rate; and tr^{FTB} is government transfer to family with children, i.e. the FTB. The FTB payment is income tested and given by $tr^{FTB} = max\{tr^{max} - \omega\left(y(l^f) - \bar{y}\right),\ 0\}$, where tr^{max} is maximum payment amount; ω is the taper rate; $\bar{y}$ is the income test threshold; $y(l^f) = (1 - l^f)w + y^m$ is the joint family income before tax and subsidy as a function of female labor supply. Let $u(c, l^f)$ denote a well-behaved utility function of consumption c and leisure l^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 argument $x \in \{c, l^f\}$. The household chooses consumption and leisure of the wife to maximize its utility $u(c, l^f)$ subject to a non-linear budget constraint.

$$c = \begin{cases} (1 - l^f)(1 + s - \omega)w + (1 - \tau - \omega)y^m + tr^{max} + \omega\bar{y} & \text{if } tr^{max} > \omega\left(y(l^f) - \bar{y}\right) \\ (1 - l^f)(1 + s)w + (1 - \tau)y^m & \text{otherwise.} \end{cases}$$

The FTB taper rate ω affects the husband's and the wife's net labor returns. In other words, ω behaves as a joint-taxation on family income. The inequality $tr^{max} > \omega\left(y(l^f) - \bar{y}\right)$ determines the wife's income zone over which the benefit applies. In other words, it can be rewritten as $(1 - l^f)w < \frac{tr^{max}}{\omega} + \bar{y} - y^m$, where the first term, $\frac{tr^{max}}{\omega} + \bar{y}$, on the RHS corresponds to the statutory cutout point of the FTB benefit. All else constant, either raising the payment rate tr^{max}, lowering the taper rate ω, or raising the income test threshold$\bar{y}$ extends the cutout point and thus the coverage of the FTB, and vice versa. Moreover, the effective FTB cutout point for the wife will shrink as the husband's earnings, y^m, increases. A larger statutory cutout point $\frac{tr^{max}}{\omega} + \bar{y}$ or lower husband's earnings y^m does not affect only the female labor supply decision below the effective cutout point, but its effect can extend to those with higher earnings depending on the preferential weight on leisure relative to consumption and the net return to labor supply.

If the wife's earnings $(1 - l^f)w$ are below the cutout point, the intra-temporal tradeoff between consumption and leisure is governed by the equation: $\frac{u_c}{u_l} = \frac{1}{(1+s-\omega)w}$. Hence, in addition to the positive income effect from the transfer, its taper rate raises the EMTR, or equivalently, lowers the marginal return to work for the wife by ω for every dollar earned. Depending the relative strength of the income-tested benefit (FTB) versus the subsidy (CCS) which determines $(s - w)$, the former can partially or completely offset the positive work incentive effect of the latter.

There are important lessons here. First, means testing adds to the complexity of the tax and transfer system. leading to a non-linear tax and transfer system and thus non-linear household budget constraint. Second, means testing family income exerts the same adverse incentive effect on labor supply decisions as a joint family income taxation. A higher taper rate results in higher EMTRs on both husband's and wife's earnings, and can weaken or amplify other policy effects. Third, all means test parameters, including the payment rates, income-test thresholds, and taper rates can cause the work disincentive effect at the extensive and intensive margins to leak into the higher income zone by expanding the cutout point of a means-testing transfer scheme. Last, the husband's labor supply can influence the effective cutout point of the benefit and therefore the strength of policy distortions on the wife's labor supply.

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 new households aged $j = 1$ (equivalent to the real age of 21) enters the economy. Each individual member of gender i 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 work and retire at age of $J_R = 45$. 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. The marital status of married households over time depends solely on survival probabilities. More precisely, a married household will become a single household if one of the spouses dies. Single households live a single life 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. 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 identical for all households. There are no informal care and bequest motives in the model economy. Households are further assumed to have the same number of children, $\bar{nc} = 2$, over their lifetime. Child spacing is identical for all parents. However, the timing of birth varies by skill type. The firstborn arrives earlier for low education (θ_L) households and later for high education (θ_H) households. 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 $nc_{j,\theta} = \sum_{k=1}^{\bar{nc}} \mathbf{1}_{\{b_{k,\theta} \leq j \leq b_{k,\theta}+17\}}$.[7]

[7] Note that, we assume children and population growth are detached. Children and child care are exogenous and

4.2 Preferences

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

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

where c_j is the joint consumption, l_j^m is the leisure time of male, l_j^f is the leisure time of female, λ_j is the household type, nc_j is the number of dependent children, and β is the time discount factor. The periodic utility functions of single male and single female differ by the presence of dependent children exclusive to the latter. The periodic household utility function for each household type can be written as follows

$$\begin{aligned}
u(c_j, l_j^m, l_j^f, \lambda_j = 0, nc_{j,\theta}) &= \frac{\left[\left(\frac{c_j}{ces(0, nc_{j,\theta})} \right)^{\nu} \left(l_j^m \right)^{1-\nu} \right]^{1-\frac{1}{\gamma}} + \left[\left(\frac{c_j}{ces(0, nc_{j,\theta})} \right)^{\nu} \left(l_j^f \right)^{1-\nu} \right]^{1-\frac{1}{\gamma}}}{1 - \frac{1}{\gamma}}, \\
u(c_j, l_j^m, \lambda_j = 1, 0) &= \frac{\left[\left(\frac{c_j}{ces(1,0)} \right)^{\nu} \left(l_j^m \right)^{1-\nu} \right]^{1-\frac{1}{\gamma}}}{1 - \frac{1}{\gamma}}, \\
u(c_j, l_j^f, \lambda_j = 2, nc_{j,\theta}) &= \frac{\left[\left(\frac{c_j}{ces(2, nc_{j,\theta})} \right)^{\nu} \left(l_j^f \right)^{1-\nu} \right]^{1-\frac{1}{\gamma}}}{1 - \frac{1}{\gamma}},
\end{aligned}$$

where ν is the taste for consumption, γ is the elasticity of intertemporal substitution (EIS) and $ces(\lambda_j, nc_{j,\theta}) = \sqrt{\mathbf{1}_{\{\lambda_j \neq 1\}} + \mathbf{1}_{\{\lambda_j \neq 2\}} + nc_{j,\theta}}$ is the family size adjustment factor (i.e., the square root consumption equivalence scale).

4.3 Endowments

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

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

where $\bar{e}_j \left(\theta, h_{j,\lambda}^m \right) = e^{\theta} h_{j,\lambda}^m$ is a non-linear function of education level θ and male human capital, $h_{j,\lambda}^m$. The stochastic shock component ϵ_j^m is modeled as an auto-regressive process

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

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 uility, 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.

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

Married and single women. In addition to 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 type and employment type. 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.[8]

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 s_j per child* if she meets the CCS eligibility criteria as laid out in section 5.5. Her earning ability is

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

where $\bar{e}_j\left(\theta, h^f_{j,\lambda,\ell}\right)$ 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 $\upsilon^f_j \sim N\left(0, \sigma_\upsilon^2\right)$.

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

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

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., $\ell = 0$.[9]

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) and per child time cost (χ_{c,j_c}) if she works full time.* With regards to the time cost (iii), we can say more precisely that at age j, her labor choice

[8]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

[9]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.

(ℓ), number (nc) and age (j_c) of children affects her leisure time l_j^f in the following sense

$$l_j^f = \begin{cases} 1 & \text{if stay at home } (\ell = 0) \\ 0 < 1 - n_{j,\lambda,\ell=1}^f - \chi_p < 1 & \text{if work part time } (\ell = 1) \\ 0 < 1 - n_{j,\lambda,\ell=2}^f - \chi_f < 1 & \text{if work full time } (\ell = 2). \end{cases} \tag{3}$$

where χ_p and χ_f are the fixed leisure costs associated with full-time and part-time work, respectively (with or without children).[10]

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.

4.4 Technology

There is a representative firm with labor-augmenting technology A and a Cobb-Douglas production function that transforms capital K and labor services L into output Y. In every period t, this is given by $Y_t = K_t^\alpha (A_t L_t)^{1-\alpha}$ where A_t grows at a 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

$$\max_{K_t, L_t} \quad (1 - \tau_t^k)(Y_t - w_t A_t L_t) - q_t K_t, \tag{4}$$

The firm's first-order conditions are:

$$r_t = (1 - \tau_t^k)\alpha \frac{Y_t}{K_t} - \delta_t, \tag{5}$$

$$w_t = (1 - \alpha)\frac{Y_t}{A_t L_t} \tag{6}$$

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.[11] 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

[10] 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.

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

zone of a progressive scheme, the FTB taper rate's effects could be less consequential compared to its effects under a proportional scheme.

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

$$tax_j = \max\left\{0, \widetilde{y}_j - \zeta \widetilde{y}_j^{1-\tau}\right\}, \tag{7}$$

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.

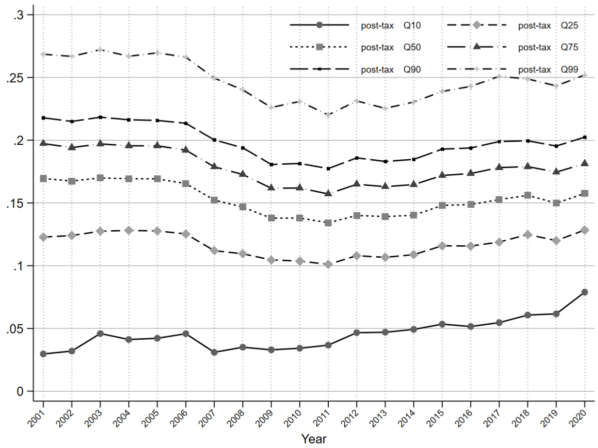

Figure 9: **Estimates of average taxes by quantiles over time using the parametric tax function 7.**
Notes: To obtain the estimates, normalize $\tilde{y}$ in the equation 7 by y_Q which corresponds to income at the Q^{th} quantile of the pre-government income distribution. When $\tilde{y} = y_Q$, it 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.

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^{A1}_j and tr^{A2}_j, (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^{A}_j, received by a household is given by

$$tr_j^A = \begin{cases} tr_j^{\mathrm{A1}} & \text{if } y_{j,\lambda} \le \bar{y}_{max}^{tr} \\ \max\left\{tr_j^{\mathrm{A2}},\ tr_j^{\mathrm{A1}} - \omega_{A1}\left(y_{j,\lambda} - \bar{y}_{max}^{tr}\right)\right\} & \text{if } \bar{y}_{max}^{tr} < y_{j,\lambda} \le \bar{y}_{base}^{tr} \\ \max\left\{0,\ tr_j^{\mathrm{A2}} - \omega_{A2}\left(y_{j,\lambda} - \bar{y}_{base}^{tr}\right)\right\} & \text{if } y_{j,\lambda} > \bar{y}_{base}^{tr}, \end{cases} \tag{8}$$

where $y_{j,\lambda} = \mathbf{1}_{\{\lambda \neq 2\}} y_{j,\lambda}^m + \mathbf{1}_{\{\lambda \neq 1, \ell \neq 0\}} y_{j,\lambda}^f + ra_j$ 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., $\bar{y}_{pe}^{tr}$ and $\bar{y}_{se}^{tr}$; and (iii) a taper rate based on the secondary earner's taxable income, i.e., ω_B. Let $y_{pe} = \max(y_{j,\lambda}^m,\ y_{j,\lambda}^f)$ and $y_{se} = \min(y_{j,\lambda}^m,\ y_{j,\lambda}^f)$ 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

$$tr_j^B = \begin{cases} \Upsilon_1 \times tr_j^{\mathrm{B1}} + \Upsilon_2 \times tr_j^{\mathrm{B2}} & \text{if } y_{pe} \le \bar{y}_{pe}^{tr} \text{and } y_{se} \le \bar{y}_{se}^{tr} \\ \\ \Upsilon_1 \times \max\left\{0,\ tr_j^{\mathrm{B1}} - \omega_B(y_{se} - \bar{y}_{se}^{tr})\right\} & \text{if } y_{pe} \le \bar{y}_{pe}^{tr} \text{and } y_{se} > \bar{y}_{se}^{tr} \\ +\Upsilon_2 \times \max\left\{0,\ tr_j^{\mathrm{B2}} - \omega_B(y_{se} - \bar{y}_{se}^{tr})\right\} & \end{cases} \tag{9}$$

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

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.[12] Key parameters determining eligibility and rate of subsidy per child include (i) joint income test thresholds; i.e., $\{\bar{y}_1^{sr}, \bar{y}_2^{sr}, \bar{y}_3^{sr}, \bar{y}_4^{sr}, \bar{y}_5^{sr}\}$; (ii) fortnightly work hour test thresholds; i.e., $\{0, 8, 16, 48\}$; and (iii) taper rates; i.e., $\{\omega_c^1, \omega_c^3\}$. The CCS rate per child, sr, at age j is given by

$$sr = \Psi(y_{j,\lambda}, n_{j,\lambda}^m, n_{j,\lambda,\ell}^f) \times \begin{cases} sr_1 & \text{if } y_{j,\lambda} \le \bar{y}_1^{sr} \\ max\{sr_2,\ sr_1 - \omega_c^1\} & \text{if } \bar{y}_1^{sr} < y_{j,\lambda} < \bar{y}_2^{sr} \\ sr_2 & \text{if } \bar{y}_2^{sr} \le y_{j,\lambda} < \bar{y}_3^{sr} \\ max\{sr_3,\ sr_2 - \omega_c^3\} & \text{if } \bar{y}_3^{sr} \le y_{j,\lambda} < \bar{y}_4^{sr} \\ sr_3 & \text{if } \bar{y}_4^{sr} \le y_{j,\lambda} < \bar{y}_5^{sr} \\ sr_4 & \text{if } y_{j,\lambda} \ge \bar{y}_5^{sr}, \end{cases} \tag{10}$$

where $y_{j,\lambda} = \mathbf{1}_{\{\lambda \neq 2\}} y_{j,\lambda}^m + \mathbf{1}_{\{\lambda \neq 1, \ell \neq 0\}} y_{j,\lambda}^f + ra_j$ is the joint income and ω_c^i is the taper rate. $\Psi(y_{j,\lambda}, n_{j,\lambda}^m, n_{j,\lambda,\ell}^f)$

[12] 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.

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 $n_j^{min} = min\{n_{j,\lambda}^m, n_{j,\lambda,\ell}^f\}$ be the household's minimum work hour. The adjustment factor is given by

$$\Psi(y_{j,\lambda}, n_{j,\lambda}^m, n_{j,\lambda,\ell}^f) = 0.24_{\{y_{j,\lambda} \leq AU\$70{,}015 \, and \; n_j^{min} \leq 8\}} + 0.36_{\{8 < n_j^{min} \leq 16\}} + 0.72_{\{16 < n_j^{min} \leq 48\}} + 1_{\{n_j^{min} > 48\}}.$$

Otherwise, $\Psi(y_{j,\lambda}, n_{j,\lambda}^m, n_{j,\lambda,\ell}^f) = 0$.

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

$$\mathcal{P}^a(a_j) = \begin{cases} p^{\max} & \text{if } a_j \leq \bar{a}_1^P \\ \max\{0,\ p^{\max} - \omega_a(a_j - \bar{a}_1)\} & \text{if } a_j > \bar{a}_1^P, \end{cases} \tag{11}$$

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

$$\mathcal{P}^y(y_{j,\lambda}) = \begin{cases} p^{\max} & \text{if } y_{j,\lambda} \leq \bar{y}_1^p \\ \max\{0,\ p^{\max} - \omega_y(y_{j,\lambda} - \bar{y}_1^p)\} & \text{if } y_{j,\lambda} > \bar{y}_1^p, \end{cases} \tag{12}$$

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

$$pen_j = \begin{cases} \min\{\mathcal{P}^a(a_j), \mathcal{P}^y(y_{j,\lambda})\} & \text{if } j \geq J_P \text{ and } \lambda = 0 \\ \frac{2}{3}\min\{\mathcal{P}^a(a_j), \mathcal{P}^y(y_{j,\lambda})\} & \text{if } j \geq J_P \text{ and } \lambda = 1, 2 \\ 0 & \text{otherwise} \end{cases} \tag{13}$$

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

$$T_t^C + T_t^K + T_t^I + (B_{t+1} - B_t) \quad = \quad G_t + Tr_t + \mathcal{P}_t + r_t B_t \tag{14}$$

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.[13]

[13]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

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 $\Lambda = \{1, 2, 3\}$, education realized at birth $\theta \in \Theta$ where $\Theta = \{\theta_l, \theta_h\}$, female human capital $h^f_{j,\lambda} \in H$ 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^m_j and $\epsilon^f_j \in S$ where $S \subset \mathcal{R}$.

Workers. Define $Z = \Lambda \times A \times H \times \Theta \times S \times S$ as the state space for each household aged $j < J_R$.[14] Let $z_j = \left\{\lambda_j, a_j, h^f_{j,\lambda,\ell}, \theta, \eta^m_j, \eta^f_j\right\} \in Z$ be a composite state variable and $V(z_j)$ be the value function for a household aged j with state z_j. For a given state combination realized at the beginning of a period, the household decides on joint consumption (c_j), female labor supply (ℓ_j), and next period joint assets (a_{j+1}) from a choice set $\mathcal{C}_j \equiv \{(c_j, \ell_j, a_{j+1}) \in \mathcal{R}_{++} \times \{0, 1, 2\} \times \mathcal{R}_+\}$ to maximize its expected lifetime utility according to

$$V(z_j) = \max_{c_j, \ell_j, a_{j+1}} \left\{ u(c_j, l^m_j, l^f_j, \lambda_j, nc_j) + \beta \sum_{\Lambda} \int_{S^2} V(z_{j+1})\, d\Pi(\lambda_{j+1}, \eta^m_{j+1}, \eta^f_{j+1} | \lambda_j, \eta^m_j, \eta^f_j) \right\} \tag{15}$$

$s.t.$

$$\begin{aligned}
(1+\tau^c)c_j + (a_{j+1} - a_j) + \mathbf{1}_{\{\lambda\neq 1,\, \ell_j \neq 0\}} fcc_j &= y_{j,\lambda} + \mathbf{1}_{\{\lambda \neq 1\}}(nc_j \times tr^A_j + tr^B_j) + beq_j - tax_j \\
c_j &> 0 \\
a_{j+1} &\geq 0 \\
l^m_j = 1 - n^m_{j,\lambda} &\quad \text{if} \quad \lambda = 0 \text{ or } \lambda = 1 \\
l^f_j = 1 - \mathbf{1}_{\{\ell \neq 0\}} n^f_{j,\lambda,\ell} - \mathbf{1}_{\{\ell = 2\}}(\chi + \chi_{c,j_c} \times nc_j) &\quad \text{if} \quad \lambda = 0 \text{ or } \lambda = 2
\end{aligned}$$

where β is the time discount factor; $y_{j,\lambda} = \mathbf{1}_{\{\lambda \neq 2\}} y^m_{j,\lambda} + \mathbf{1}_{\{\lambda \neq 1,\, \ell_j \neq 0\}} y^f_{j,\lambda} + r a_j$ is the total household market income; $fcc_j = \sum_{i=1}^{nc_j}(1 - sr_{j,i})\kappa_{j,i} w n^f_{j,\lambda}$ is the net formal child care cost; tr^A_j and tr^B_j are the FTB part A and B transfers; $\kappa_{j,i}$ and $sr_{j,i}$ are the hourly child care cost as a fraction of hourly wages and CCS subsidy rate for the i^{th} child of a household aged j, respectively; τ^c is the consumption tax; and $tax_j = \mathbf{1}_{\{\lambda \neq 2\}} tax^m_j + \mathbf{1}_{\{\lambda \neq 1\}} tax^f_j$ is the income tax payment. 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_j, from deceased households of the same period.

Retirees. Retirement at age J_P, when households become eligible for the Age Pension, 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 the pension age, retirees are not eligible for

allows a realistic consumption path in a model environment with γ within the standard value range of gamma.

[14] 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.

any child-related transfers. Pension payout is not conditional on earnings history but is conditional on household type, λ. An eligible single household receives only two-third of the maximum pension payment that a couple would receive. The state vector of a retired household is therefore simplified to $z_j^R = \{\lambda_j, a_j\} \in \{0,1,2\} \times R_+$. The retired household optimization problem reduces to

$$V(z_j^R) = \max_{c_j, a_{j+1}} \left\{ u(c_j, \lambda_j) + \beta \sum_{\Lambda} V(z_{j+1}^R)\, d\Pi(\lambda_{j+1}|\lambda_j) \right\} \tag{16}$$

$$s.t.$$

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

where pen_j is the total age pension described in equation 13.

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.[15] Given that households enter the economy with zero human capital ($h_{j=1} = 0$) and assets ($a_{j=1} = 0$), the initial distribution of newborns ($j = 1$) in every period t is determined by

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

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

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

$$\phi_{t+1}(z^+) = \int_{\Lambda \times A \times H \times \Theta \times S^2} \mathbf{1}_{\{a^+ = a^+(z,\Omega_t),\, h^+ = h^+(z,\Omega_t)\}} \times \pi(\lambda^+|\lambda) \times \pi(\eta_+^m|\eta^m) \times \pi(\eta_+^f|\eta^f)\, d\Phi_t(z) \tag{17}$$

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. In practice, assets and human capital are discretized. These endogenous states however evolve continuously, and for this reason, the share of households on each of the next period (a^+, h^+) pairs are obtained through linear interpolations of $a^+$and $\log(h^+)$ on the current period assets (A) and human capital (H) discretized domains, respectively.

[15] 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.

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, the per capital terms of consumption C_t, private wealth A_t, female labor force participation rate LFP_t, and labor supply in efficiency unit for male LM_t and female LF_t in every period t are expressed as

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

The aggregate government variables are

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

where $ftba_j, ftbb_j$ and ccs_j are the total FTB A, FTB B and CCS benefits for cohort j, and the total labor supply in efficiency unit $L^s_t = LM_t + LF_t$.

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

(a) The collection of individual household decisions $\{c_j, \ell_j, a_{j+1}\}_{j=1}^{J}$ solves the household problem 15 and 16;

(b) The firm chooses labor and capital inputs to solve its profit maximization problem 4;

(c) The government periodic budget constraint 14 is satisfied;

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

$$\begin{aligned} K_t^s &= A_t + B_{F,t} - B_t \\ L_t^s &= LM_t + LF_t; \end{aligned}$$

(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.[16]

(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.[17] 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.[18] 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

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

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

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

[18]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.

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 20122018 key statistics of the Australian economy, a period of relative stability in macroeconomic indicators such as household consumption and asset growth.[19] 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 ($j = J = 80$).[20] 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 $\pi(\lambda = 2) = 0.16$.[21] Figure 10 reports shares of survivors by marital status 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.[22] 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.

[19] 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.

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

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

[22] $\beta = 0.99$ 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.

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 2010-2018
Technology		
Labor augmenting technology growth	$g = 1.3\%$	Average per hour worked growth rate (World Bank 2012-2018)
Output share of capital	$\alpha = 0.4$	Output share of capital for Australia
Real interest rate	$r = 4\%$	Average (World Bank 2012-2019)
Households		
Relative risk aversion	$\sigma = 1/\gamma = 3$	Standard values 2.5-3.5
Male and female labor supply	$n_{m,\lambda},\ n_{f,\lambda}$	Age-profiles of average labor hours for employees (HILDA)
Male human capital profile	h^m_λ	Age-profile of wages for married 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	$\tau^c = 8\%$	$\tau_c \times \frac{C_0}{Y_0} = 4.5\%$; given $\frac{C_0}{Y_0} = 56.3\%$
Company profit tax	$\tau^k = 10.625\%$	$\tau^k \left(\frac{Y - WL}{Y}\right) = 4.5\%$; where $\frac{WL}{Y} = 1 - \alpha$
Government debt to GDP	$\frac{B}{Y} = 20\%$	Average (CEIC 2012-2018)
Government general purchase	$\frac{G}{Y} = 14\%$	Net of FTB, CCS and Age Pension (WDI and AIHW)
FTB, CCS and Pension parameters		HILDA tax-benefit model
Others		
Model income unit	1 model unit = $\$24.02/hour \times 24 \times 5 \times 52$	Average married men's hourly wage at age 21 (HILDA)*

Table 2: Externally calibrated parameters

Notes: (*) The age-profile of hourly wages for married men is obtained by regressing $log(wage)$ on quadratic age terms and four dummies (gender, marital status, employment type and time). We then normalize all hourly wage estimates by the average hourly wage of male aged 21. 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 6872% 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.

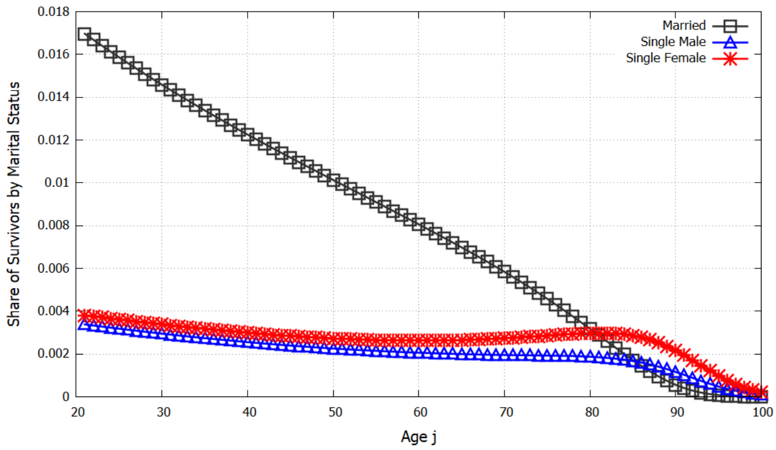

Figure 10: **Time-invariant shares of survivors by family type over the life-cycle.**

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_υ^2. We set $\rho = 0.98$ to stay within bound of the common values in the literature and calibrate σ_υ 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.[23] 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[24]

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

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_λ^m and $n_{\lambda,\ell}^f$)

[23] σ_υ 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.

[24] 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.

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 ($\ell = 2$).[25] The average work hours are estimated from HILDA as shown in Figure 11.

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.[26]

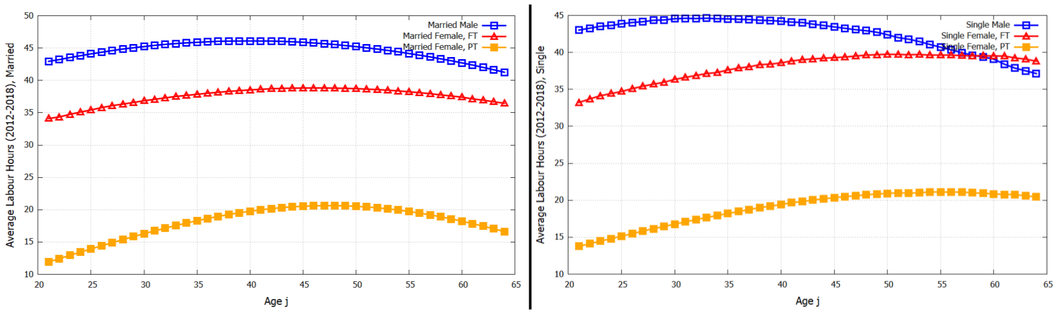

Figure 11: **Labor supply over the life cycle.** **Left panel:** Age profiles of average work hours for married parents if employed. **Right panel:** Age profiles of average labor hours for single men and single mothers if employed. Note: the difference between the two y-axes. The former ranges from 10 to 50 hours and the latter from 10 to 45 hours.

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.[27] The heterogeneity pertaining to children is attached

[25] 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 1*p.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 4.3*pp* (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.

[26] 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.

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

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.[28] For tractability and based on the observation that women constitute the majority (87.21) of lone parents in our sample, we assume only single women and married households in the model have children.[29]

Child care cost. We abstract from informal child care and restrict the formal care service to have identical quality and price (a perfectly competitive market environment). With a conservative estimate of \$12.5 per hour, the cost of child care is 52% of a 21-year-old 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). That is, 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.[30]

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 5 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, $\dfrac{\tau^c C}{Y}$, of

above. Hence, the average number of children in our model is not far off the actual figure.

[28] 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.

[29] 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 $0.86 \times 2 = 1.72$.

[30] 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 68 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.

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.

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.

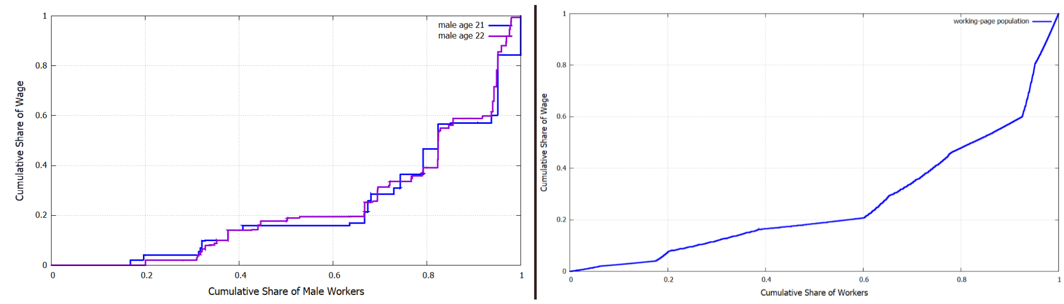

Figure 12: **Lorenz curves of wage distributions. Left panel:** Lorenz curves of the distributions of married male wages at age 21 and 22 (Gini = 0.35). **Right panel:** Lorenz curve of the wage distribution of working-age male population (Gini = 0.3766). Wages in the model account for human capital, education and transitory shocks over the life-cycle .

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.

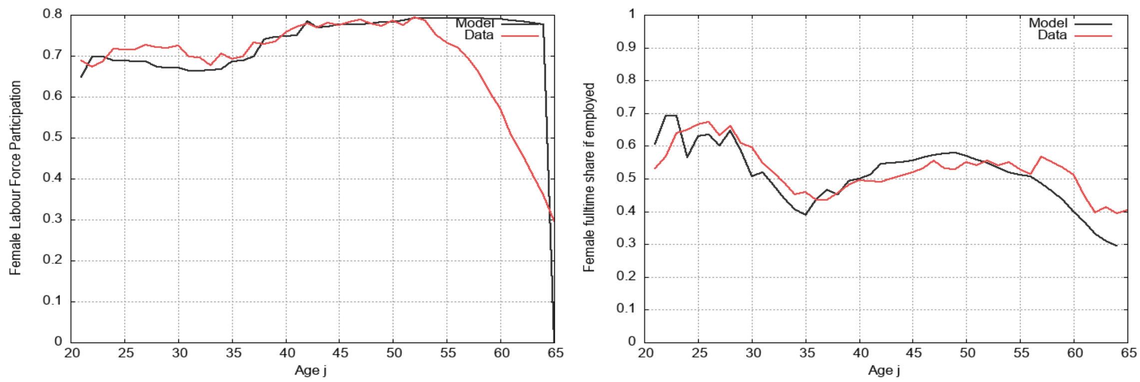

Figure 13: **Model vs Data: Life-cycle profiles of labor supply of mothers. Left panel:** Life cycle profile of labor force participation. **Right panel:** Life cycle profiles of full-time share of employment.

Figure 13 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 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 investigate the radical reform path of universal child-related transfers by comparing their efficiency and welfare outcomes to the benchmark means-tested child-related transfers. In an extension of our primary analysis (refer to section 6.3), we assess additional scenarios of simple incremental regime changes and their aggregate implications. Any discrepancies between the government's consolidated tax revenues and expenditures 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 efficiency and welfare 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 efficiency. 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. A society that places its concern on the long-run welfare outcome 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.[31]

From these experiments as well, 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

[31]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.

stem from: (i) the targetedness of child-related transfers via means-testing which curtails baseline 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).[32] 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 benefits.

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 4.27% 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 no longer funding 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 3.86% increase in aggregate consumption. The puzzle is the 0.66% welfare loss for newborn households, despite the notable consumption and output gains. This loss is primarily due to the way family structure is modeled. In a setup without family type heterogeneity, 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 heterogeneity in 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 14). 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 loss in child benefits. Without the CCS, the monetary costs of formal child care substantially diminish 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.

The factors previously discussed explain the sharp welfare reductions for single mothers, as seen

[32] 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.

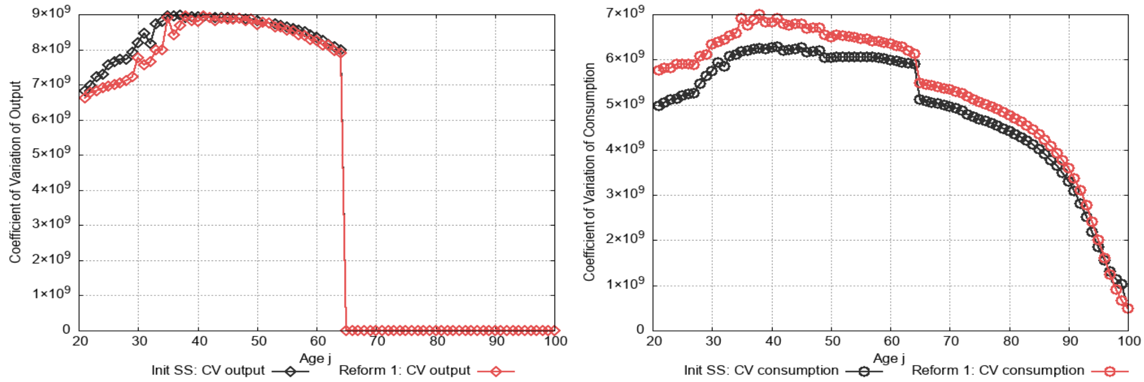

Figure 14: **Coefficients of variation of log output and log consumption: Benchmark (black) vs FTB and CCS elimination reform (red). Left panel:** Life cycle profile of coefficient of variation of log output. **Right panel:** Life cycle profile of coefficient of variation of log consumption.

in the last row of Table 6. Specifically, welfare plummets by 4.03% for highly-educated single mothers and 6.53% for those with low education. In contrast, for married mothers with low education, the insurance provided by their partners (or, family insurance) mitigates the loss, keeping it relatively small at 0.22%. Hence, a society concerned with the long-term welfare of its newborns would not favor the complete removal of child-related transfer policies.

6.2 Means-testing or universal

6.2.1 Empirical context

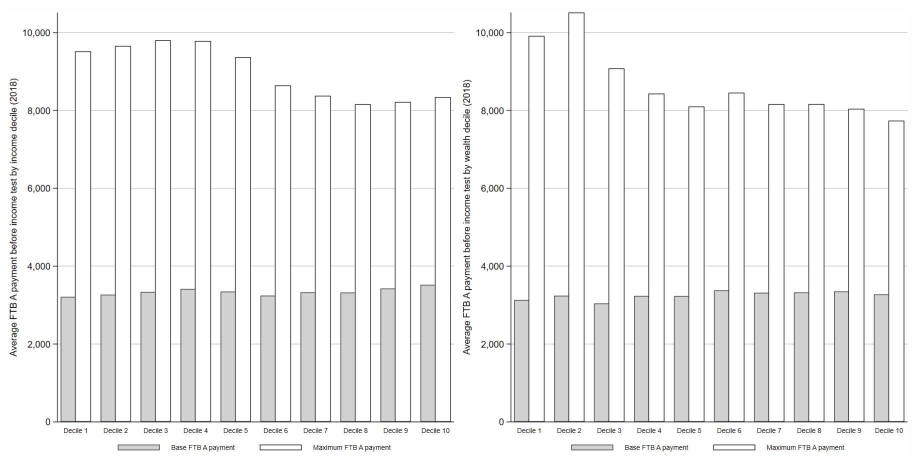

Figure 15: **Average FTB A base and maximum benefits before income test by income and wealth deciles of 2018.**

For context, we begin by providing empirical estimates related the FTB-A, the predominant component of the FTB transfer. Specifically, we utilize the HILDA tax-benefit model to compute the potential average payment and share of beneficiaries prior to income tests in 2018, stratified by income and wealth deciles. The resultant visual data shown in Figure 15 and 16 shed light on what a universal scheme would look like in practice. First, if the scheme was universal, all eligible parents would be entitled to the maximum payment, making the base payment irrelevant. Second, while lower-decile households would accrue benefits between $AU\$9,000$ and $AU\$10,000$, better-off households above the median income or wealth could still secure approximately $AU\$8,000$. Third, according to Figure 16 which shows the extensive margin of the FTB-A, we can also observe that significant fractions of these richer households would be eligible for the transfers.

Therefore, these increases in the intensive and extensive margins of child-related transfers imply: (i) the program would expand greatly and intensify the tax burden; (ii) depending on how the tax channel operates, the outcome could be efficiency and welfare losses; and (iii) there could be welfare transfers to more affluent households. A detailed quantitative analysis of this scenario ensues in the section below.

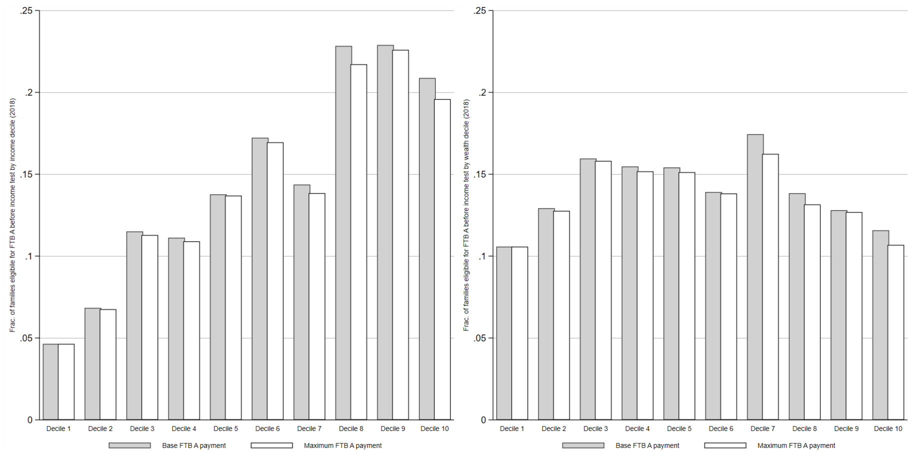

Figure 16: **Potential beneficiaries before income test by income and wealth deciles in 2018.**

6.2.2 Efficiency and welfare consequences of universalizing child-related transfers

In this subsection, through the lens of our model, we quantify the effects of a radical reform under which the government provides universal child-related lump sum payments and work subsidies to families with children by removing all means testing rules from the FTB and CCS programs.

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 human capital and output gains of 2.09% and 0.11%, respectively. Correspondingly, ex-ante welfare for the average household 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 efficiency and welfare 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 means-tested transfers in all key metrics. However, the aggregate changes mask the heterogeneous effects on different households. For a more detailed 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 can claim maximum FTB transfers. This eliminates the work disincentive associated with income tests. Moreover, the universally availability of the CCS program, awarding maximum child care cost subsidies, provides an extra layer of incentive. For most households, the work incentives appear to dominate the work disincentives 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.[33]

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.

Interestingly, despite the radical nature of the reform, single mothers' labor supply remains largely inelastic, with only a minor fraction transitioning out of full-time employment. There are two 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 cycles. Consequently, they are 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 brackets and is generally smaller for low-educated single mothers.[34]

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 welfare implications. Married households emerge as the sole beneficiary of this reform. Both low- and high-educated couples see substantial increases in consumption over their lifetimes, 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.

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

[34] Note that, this is partly 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.

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.

On the other hand, all single households, including single mothers - the primary target of the program - are the losers under the universal system. The main source of their losses seems to be the large 4.2*pp* surge in the average tax rate in the new economy, owing to the significant expansions in child-related transfer programs. In fact, the FTB and the CCS inflate by 281.4% and 129.45%, respectively. Single men are inevitably the most affected as they reap no transfer benefits and have to pay higher taxes. Particularly, high-educated single men bear the largest penalty due to the progressive tax system.

The surprising welfare outcomes are those of single mothers. High-educated single mothers see a decline in their welfare by 0.69%, while their low-educated counterparts register a 0.51% dip. It is worth noting that, they maintain their pre-reform labor supply commitment despite the introduction of universal transfers. This suggests that, even without means-testing, the benchmark transfer amount for single mothers (limited to the duration when young children are in the household) is not sufficient to replace the labor income and accumulated human capital they gain from working. Consequently, although the increased tax burden in the counterfactual economy has virtually no effect on their labor supply, it serves to lower their consumption capabilities over the greater part of their life cycles, 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-educated 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 (i.e., ex-ante welfare or long-run welfare). 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 extract some important takeaways.

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.

Table 10 displays the efficiency and welfare outcomes from chosen incremental reforms. There are some notable observations. First, the top row (tax rate changes) suggests that, in a model with progressive tax and household 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 a trade-off between efficiency and welfare. Third and most important, 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.

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 has been shown to be 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, note that high-educated and low-educated married households experience welfare gains of 1.36% and 1.34%, respectively, under the universal regime, albeit at the expense of the single households (as detailed in 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 more equitable outcomes across multiple dimensions, 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.

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.

7 Conclusion

This paper marks the first attempt to cast two major child-related transfers based on the Australian targeted welfare design - the Family Tax Benefits and the Child Care Subsidy - into a general equilibrium heterogeneous-agent overlapping generations model to examine their aggregate efficiency and welfare implications. Through steady state analyses, our findings reveal that child-related transfers are desirable from the welfare perspective, but they come at some efficiency costs. Means-testing of child benefits is an effective instrument to control the size of public funds; however, it induces work disincentive effects via increased effective marginal tax rates (EMTRs). A transition from the benchmark means-tested system to a universal system can improve both aggregate efficiency and welfare, and is favored by the majority. Nevertheless, this reform unexpectedly leads to welfare losses 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 more equitable improvements, but might lack majority endorsement.

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 aggregate effects and unveiling the underlying welfare redistributions. Third, simple incremental reforms could lead to modest but more equitable gains. Last but not least, they suggest that one should not consider a policy reform in isolation. Policies interact such that eliminating one does not always alleviate its associated 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 might prevent immediate labor market responses, and political frictions that might impede automatic adjustments of one program spending in response to a reform of another program. Neither is there any administrative overhead that exacerbates the inefficiency of operating multiple complex support programs under a single welfare system. We also do not encode 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 reform effects on tax, large increases in the tax burden from radical reforms (e.g., universal child-related transfers) could realistically induce male labor supply responses. Moreover, the model economy omits childless married households 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 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 full transitional dynamics between steady states. Therefore, the welfare implications for non-newborn generations living in the reform phase - who, upon birth, have committed to optimal decision paths and do not anticipate the reforms we introduce - are not captured. 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 GDP 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

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

The maximum threshold is fixed while the base threshold expands at the rate of $FTBA_{T_2 A}$ 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 $FTBA_{T_2 A} = 0$,all stated in 2018 AU$.

We can then calculate the FTB A benefit.

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

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

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

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

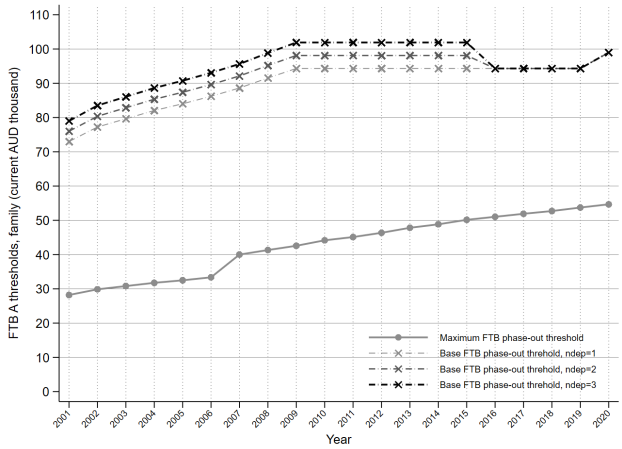

Figure A.1: FTB-A income test thresholds for maximum and base payment rates

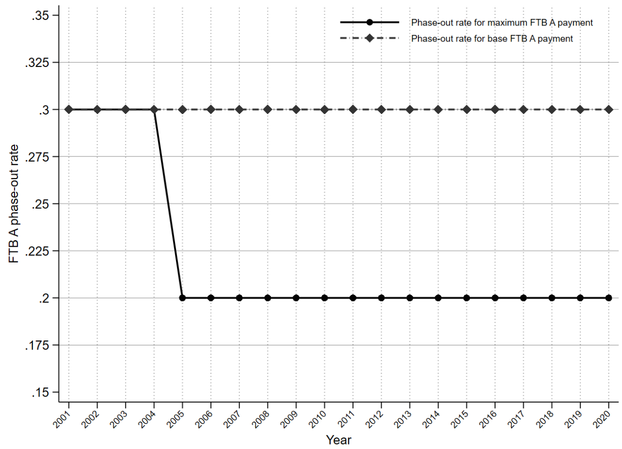

Figure A.2: FTB-A taper/phase-out rates for maximum and base payments

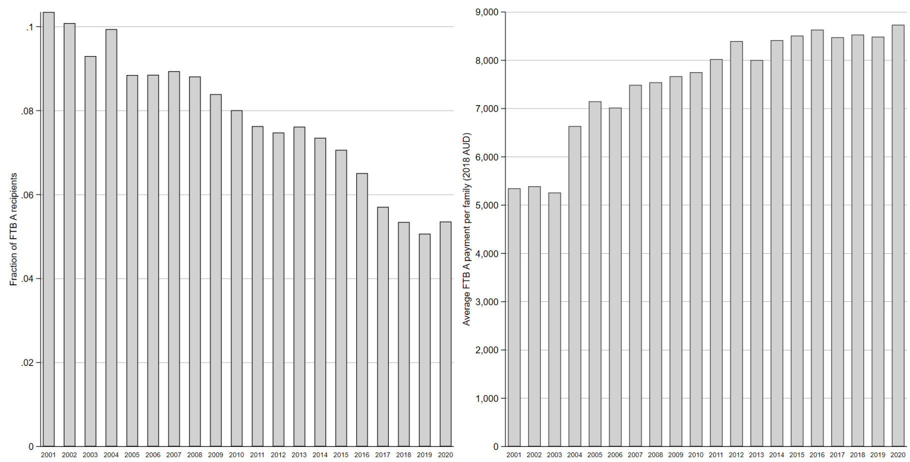

Figure A.3: **Fractions of FTB-A recipients and average FTB-A payment per family (2018 AUD) over time.**

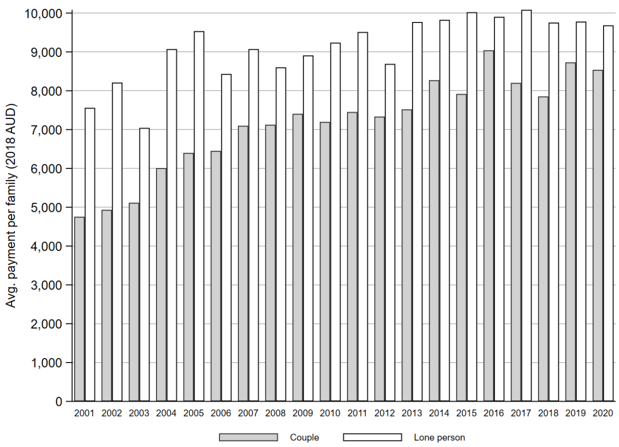

Figure A.4: Average FTB-A payment per family by marital status

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

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

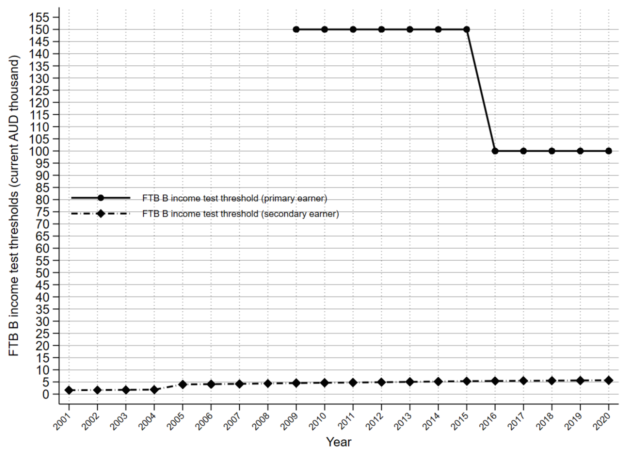

Figure A.5: **FTB-B thresholds over time on primary and secondary earners over time.**

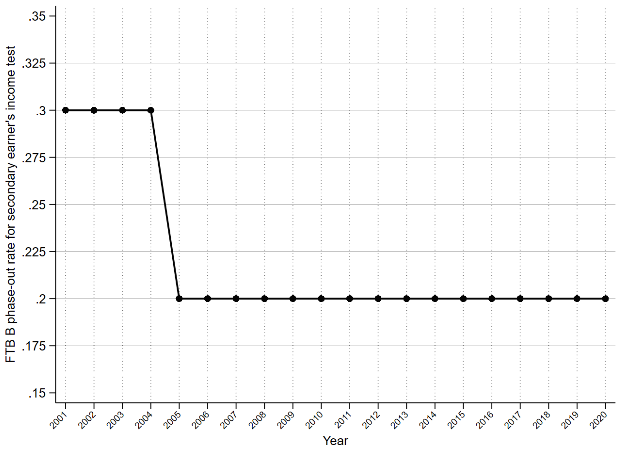

Figure A.6: **FTB-B taper rates over time.**

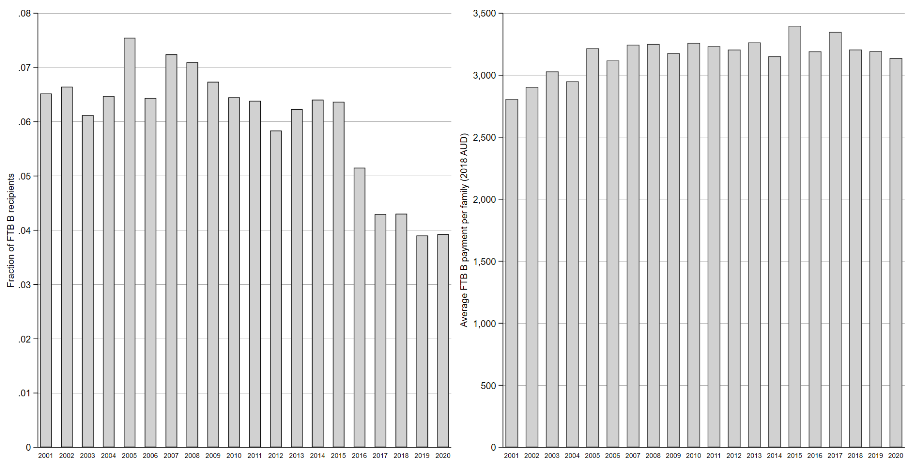

Figure A.7: **Fractions of FTB-B recipients and average FTB-B payment per family (2018 AUD) over time.**

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,[35]
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 7

We divide Y of 7 by the income level Y_Q associated with the Q^{th} quantile of interest.

[35] 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

$$T_{Y_Q} \quad = \quad 1 - \zeta \tag{A.16}$$

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.,

Quintile	Parenthood	Gender	Marital status	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.**

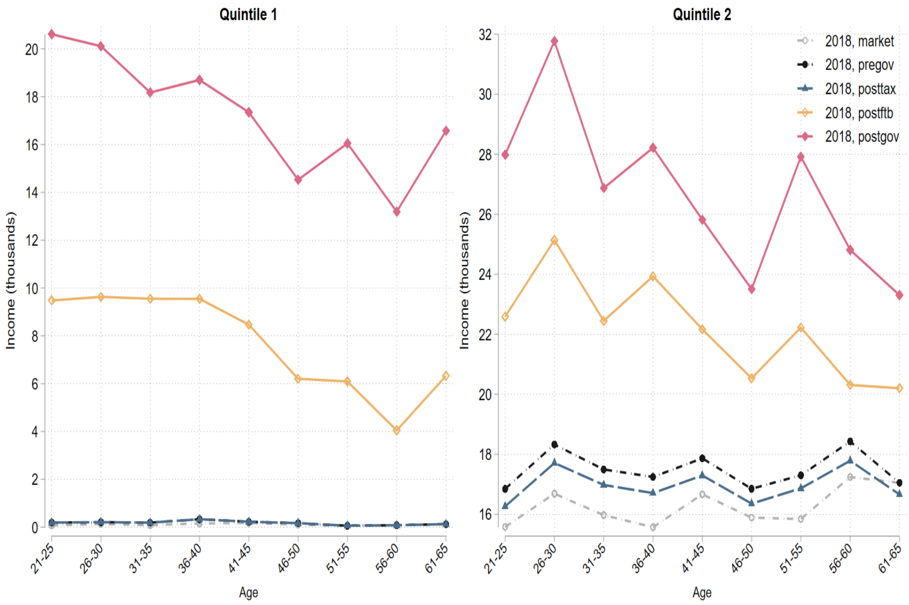

Figure A.8: **Age profiles of income at different levels for parents in the bottom two quintiles of pre-government income.**
Notes: Pre-government income (black line) is a combined income from all market sources and private transfer before tax and public transfer. Post-tax income (blue line) is pre-government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

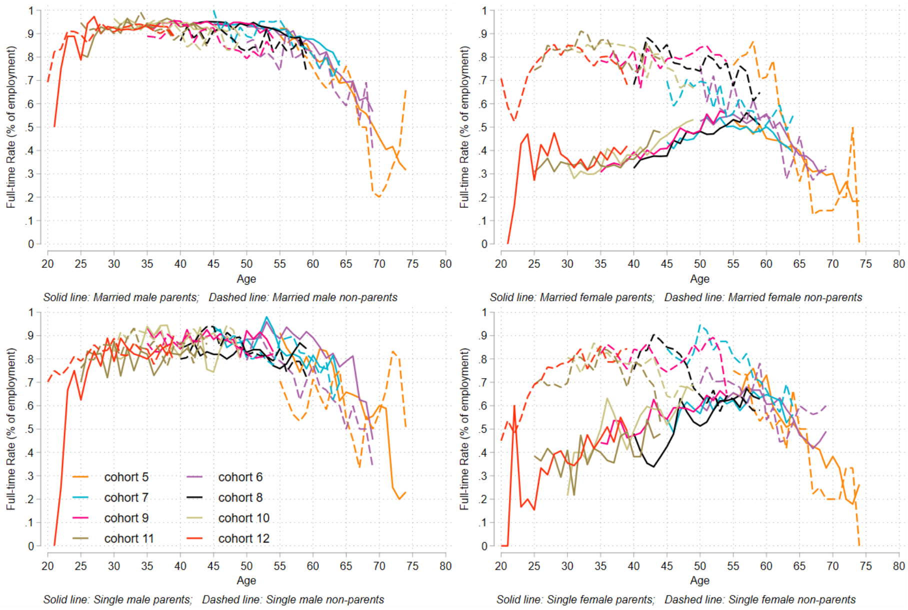

Figure A.9: **Age profiles of full-time share of employment by key demographics (gender, marital status and parenthood). Top left:** married fathers (solid) and married childless men (dashed). **Top right:** married mothers (solid) and married childless women (dashed). **Bottom left:** single fathers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

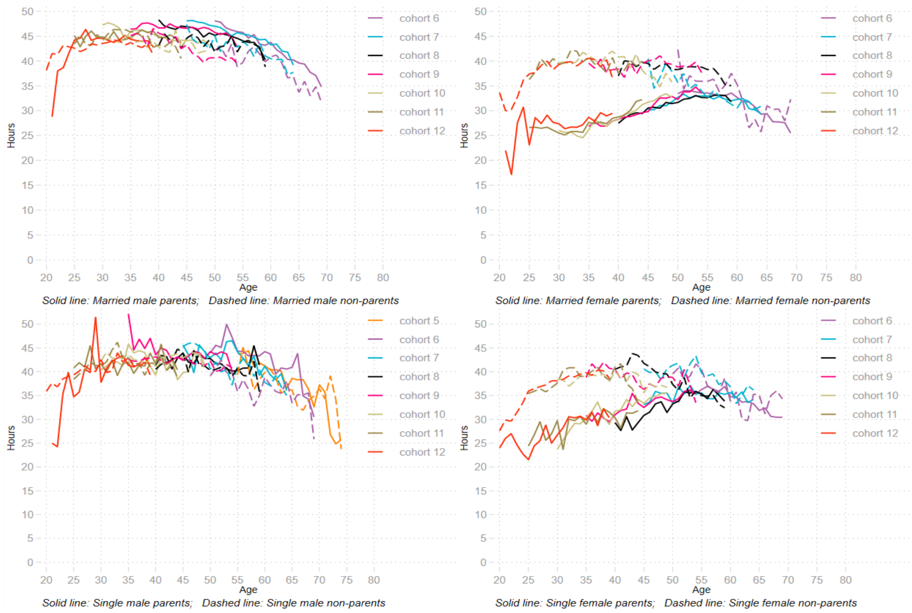

Figure A.10: **Age profiles of work hours (if employed) by key demographics (gender, marital status and parenthood). Top left:** married fathers (solid) and married childless men (dashed). **Top right:** married mothers (solid) and married childless women (dashed). **Bottom left:** single fathers (solid)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

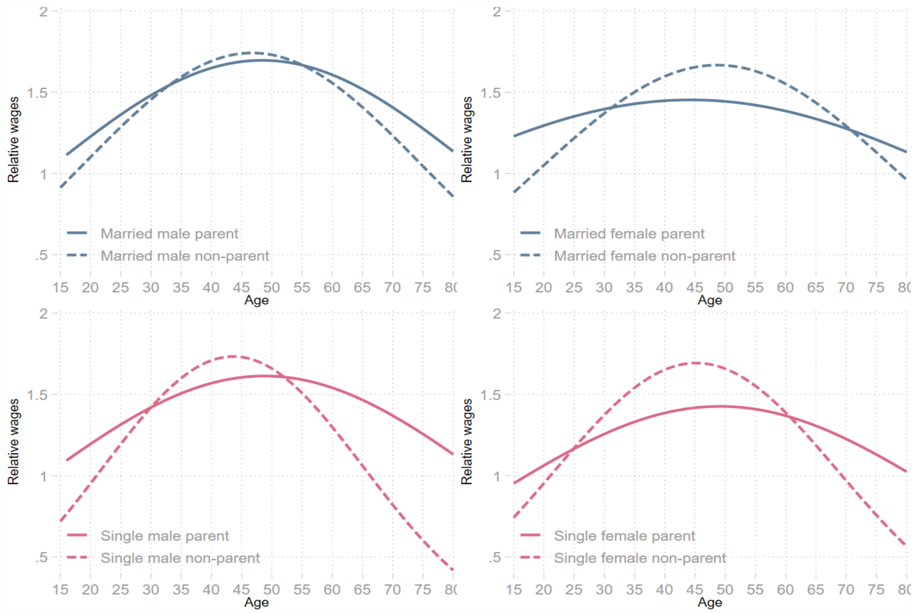

Figure A.11: **Age profiles of normalized wages (against age-21 worker's average wages) by key demographics (gender, marital status and parenthood). Top left:** married fathers (solid) and married childless men (dashed). **Top right:** married mothers (solid) and married childless women (dashed). **Bottom 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;[36]
    - $h^f_{max,\lambda=0,\ell} = h^m_{max,\lambda=0,\ell}$ 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;

[36] 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 2;

   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).[37]

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.

[37] 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

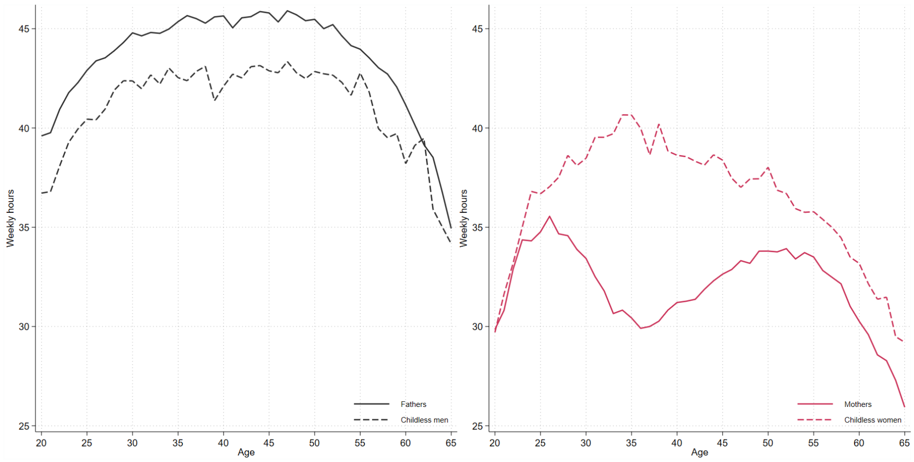

Figure C.1: Intensive margin: Age profiles of work hours (if employed) by key demographics (gender and parenthood). Left: fathers (solid) and childless men (dashed). Right: mothers (solid) and childless women (dashed).

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.

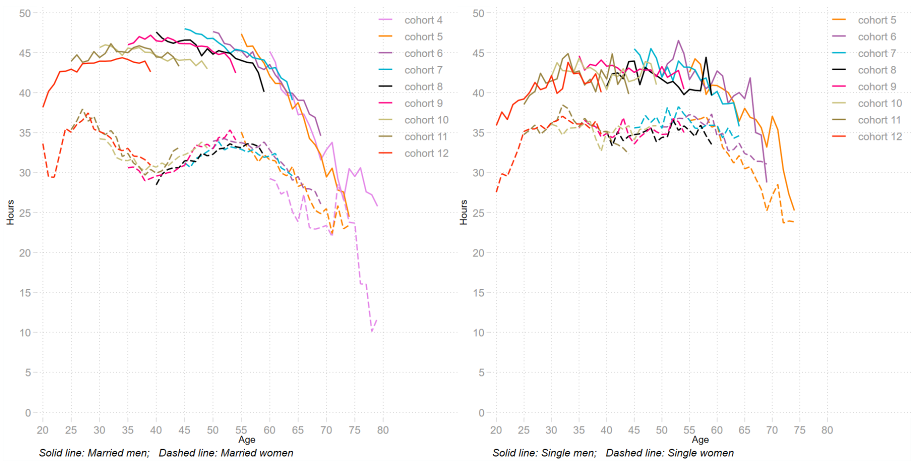

Figure C.2: Intensive margin: Age profiles of work hours (if employed) by marital status and gender. Left panel: married men (solid line) and married women (dashed line). Right panel: single men (solid line) and single women (dashed line).

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.

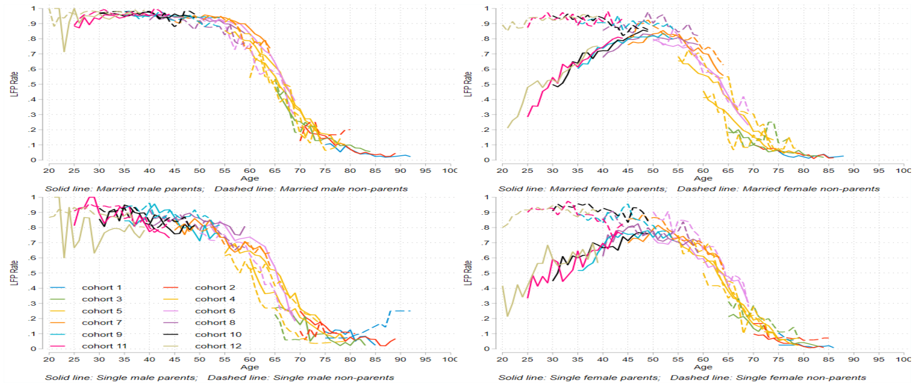

Figure C.3: **Extensive margin: Age profiles of labor force participation by key demographics (gender, marital status and parenthood). Top left:** married fathers (solid) and married childless men (dashed). **Top right:** married mothers (solid) and married childless women (dashed). **Bottom left:**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

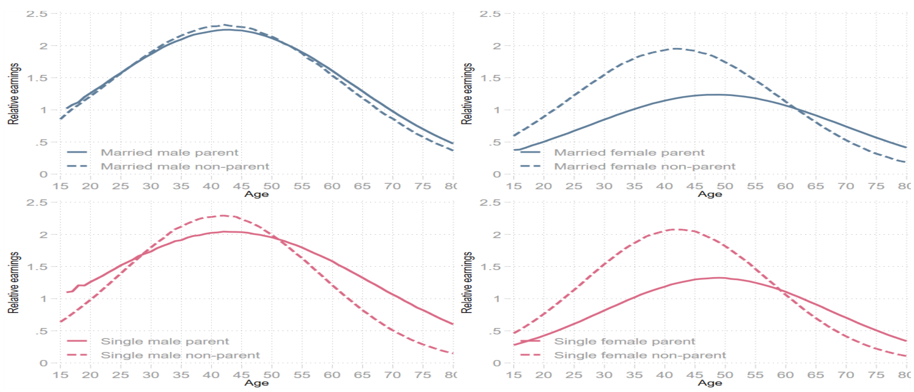

Figure C.4: **Age profiles of normalized weekly earnings (against age-21 worker's average earnings) by key demographics (gender, marital status and parenthood). Top left:** married fathers (solid) and married childless men (dashed). **Top right:** married mothers (solid) and married childless women (dashed).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