

On the Joint Optimal Design of Taxes and Child Benefits*

(Updated Regularly: [Latest version](#))

Darapheak Tin[†]
Australian National University

December 15, 2024

Abstract

Progressive income tax and means-tested child benefit systems are designed to support low-income families; however, their interaction generates high and non-linear effective marginal tax rates (EMTRs), which create substantial work disincentives, especially for low-income mothers. In this paper, I document this equity-efficiency trade-off using Australian household survey data (HILDA), explore how tax and child benefit systems should be designed to maximize (ex-ante) welfare, and examine their macroeconomic and distributional implications. To this end, I develop a dynamic general equilibrium model of overlapping generations, calibrated to Australia (2012–2018), featuring rich household heterogeneity in family structure, female human capital, uninsurable earnings risks, and the age and number of children. Assuming a utilitarian social welfare function, I find that optimal tax reform entails reducing tax progressivity, shifting tax burdens from high- to low-income households to incentivize longer work hours. This scheme produces a modest welfare gain but disadvantages some low-education parents, thereby undermining the objectives of child benefit programs. I demonstrate that a joint optimal system—combining reduced tax progressivity with a universal lump-sum child benefit at 30% of average income—yields superior overall and parental welfare outcomes. While reduced tax progressivity benefits high-education parents, the joint design allows for transfers to compensate low-education parents for their increased tax liabilities. However, this approach imposes notable welfare losses on non-parent households due to the higher overall tax burden required to fund the expanded child benefit program. Moderately scaled-back transfers, deviating from the optimal level, provide smaller welfare gains to parents but at substantially lower costs to non-parents, whereas overly generous transfers lead to excessive tax burdens, contracting the economy and ultimately harming the intended beneficiaries. These findings highlight the importance of policy coordination and fiscal sustainability in effectively supporting vulnerable parents while balancing equity and efficiency considerations.

JEL: E62, H24, H31

Keywords: Child Benefits; Means-Testing; Progressive Taxes; Female Labor Supply; Optimal Taxes and Transfers; Welfare; Welfare Decomposition; Dynamic General Equilibrium.

*I would like to thank my PhD supervisors A/Prof. Chung Tran, A/Prof. Timothy Kam and Dr. Timo Henckel for their guidance and insightful feedback. I appreciate comments from the participants of the 2024 WAMS conferences and seminars at the Australian National University.

[†]Research School of Economics, Australian National University, email: darapheak.tin@anu.edu.au

1 Introduction

Means-tested child benefits—including direct cash transfers, child care subsidies, child tax credits, and other in-kind support—along with a progressive tax system, serve as important government insurance mechanisms for low-income families with dependent children. Means testing, often based on family income, ensures that limited public funds are directed to those most in need while promoting fiscal sustainability. However, my empirical documentation based on Australian household survey data (HILDA) reveals that the interaction between child benefit phase-outs and marginal tax rates (MTRs) creates persistently high, non-linear, and non-monotonic effective marginal tax rate (EMTR) schedules for secondary earners—predominantly women—resulting in significant disincentives for female labor supply across income levels.

This insurance-incentive trade-off lies at the intersection of labor economics, macroeconomics, and public finance research. Prior studies have addressed related issues from various perspectives. The optimal tax literature (e.g., [Ramsey 1927](#), [Mirrlees 1971](#), [Atkinson and Stiglitz 1976](#), [Diamond 1998](#), [Saez 2002](#)) primarily examines minimizing inefficiencies in public revenue collection through direct and indirect taxes, focusing on individual heterogeneity in income and abilities. However, these analyses often abstract from considerations pertaining to the design of transfer systems and specific transfer programs. More recent contributions have introduced heterogeneity in individual/household characteristics—such as gender, marital status, and parental status—to assess tax policies (e.g., [Guner et al. 2012a](#), [Guner et al. 2012b](#), [Bick 2016](#), [Bick and Fuchs-Schündeln 2018](#)) or specific transfer designs (e.g., [Baker et al. 2008](#), [Kaygusuz 2015](#), [Nishiyama 2019](#), [Borella et al. 2020](#)). These studies highlight demographic differences and primarily focus on female labor supply and household welfare outcomes from policy reforms, yet often abstract from questions of optimality or the joint design of tax and transfer systems.

In this paper, I examine the interplay between tax and child benefit systems, proposing optimal (ex-ante welfare-maximizing) designs for different policy settings, and evaluating their aggregate and distributional effects within a structural framework that accounts for household heterogeneity in education and family structure, including gender, marital, and parental status. My contributions are twofold.

First, children impose unique costs on household consumption and leisure that tax reforms—focused solely on redistribution along income dimension—cannot address. Targeted child benefits are designed to mitigate these challenges for parents, while income taxes influence welfare and work incentives among high-education and non-parent households in ways unachievable through child benefit programs. A key contribution of this paper lies in (i) integrating tax and child benefit systems, and (ii) endogenizing their interaction within a model that incorporates demographic heterogeneity. By doing so, the study highlights how a joint optimal design of these policy instruments compares to standalone optimal tax or child benefit reforms in terms of aggregate and distributional implications.

Second, existing studies on joint tax and transfer reforms largely focus on the U.S. context and often involve a broad array of transfers (e.g., [Guner et al. 2023](#) and [Ferriere et al. 2023](#)).¹ However, policy alternatives outside the U.S., including child-related transfers, remain less studied. This paper contributes to the literature by analyzing tax and child benefit policies in Australia, where lump-sum child-related transfers play a prominent role. These transfers support over one million families, with average payment rates reaching up to 40% of total income for low-income households. Specifically, Australia’s system implements two primary means-tested child benefits based on family income: the Family Tax Benefit (FTB), a direct lump-sum transfer for families with dependent children, and the Child Care Subsidy (CCS), which subsidizes formal child care costs for working parents. Both operate within a moderately progressive tax regime.²

My analysis is based on a dynamic general equilibrium model with overlapping generations of households

¹[Guner et al. 2023](#) explore alternatives to means-tested transfers for working-age households and progressive taxation, such as combining universal transfers with proportional tax regimes. [Ferriere et al. 2023](#) optimize tax and transfer systems, each represented by a parametric function.

²The system also employs fine-tuning instruments—such as multi-tier family income tests and demographic criteria (e.g., marital status, number and age of dependent children)—to determine eligibility and benefit levels. Further details are provided in Appendix Section [H.2](#). For a more in-depth discussion of the Australian child-related transfer system, see [Tin and Tran 2024](#).

making joint decisions on consumption, savings, and female labor supply (participation and hours). The current framework treats children as deterministic and exogenous to make feasible rich household heterogeneity in key characteristics—such as family structure, age and number of children, asset holdings, education, female human capital, and uninsurable idiosyncratic earnings risks. This configuration then allows for the modeling of endogenous consumption, savings, and female labor supply in a general equilibrium setting where child-related transfers are funded through the income tax system. This model serves as a baseline for future extensions that incorporate other important mechanisms, such as endogenous fertility and child quality channels.

In this study, an optimal policy maximizes ex-ante welfare (under the veil of ignorance) derived from household consumption and leisure. While the social welfare function is utilitarian, the distributional implications of the optimal policy are also reported for completeness and transparency. Welfare changes are measured using Consumption Equivalent Variation (CEV) and decomposed into consumption- and leisure-driven components. Adapting the approach of [Bhandari et al. \(2021\)](#), these components are further broken down into three effects: (i) *allocative efficiency*, reflecting changes in average consumption/leisure levels over the life cycle; (ii) *distributional (equity)*, capturing changes in ex-ante consumption/leisure shares relative to the population average; and (iii) *insurance*, representing changes in ex-post risks to consumption/leisure. This decomposition enables a detailed examination of the underlying factors driving household welfare.

I discipline the model using 2012-2018 macroeconomic aggregates and household-level microdata from Australia. Taking the calibrated model as a baseline, I assess a series of counterfactual reforms that modify key policy levers while adjusting income taxes to maintain government budget balance. The income tax policy lever is the progressive parameter (τ), and the budget-balancing variable is the tax scale parameter (ζ), based on the parametric tax function from [Feldstein \(1969\)](#), [Benabou \(2000\)](#) and [Heathcote et al. \(2017\)](#), as detailed in Subsection 4.5.1. The child benefit policy lever is a universal lump-sum payment rate per child (\bar{t}), which replaces the means-tested FTB program. Throughout the experiments, the parameters of the Child Care Subsidy (CCS) are kept unchanged, but the subsidy amount can adjust endogenously to changes in parental labor supply. The main findings are summarized as follows.³

In the first experiment, I restrict reforms to the tax system while retaining the benchmark means-tested child benefit program. I find that the optimal tax regime requires reducing tax progressivity ($\tau^* = 0.1$) from the baseline level ($\tau = 0.2$).⁴ This reform lowers marginal tax rates (MTRs) across higher earnings levels. For instance, MTRs decline from approximately 28% to 19% for average-income earners and from 38% to 25% for those earning twice the average income. These reductions promote longer work hours and increased consumption, including among young, low-education single mothers.⁵ The overall welfare increases by 1.38%, mainly driven by improved consumption allocative efficiency (CEV_{CE}). However, by shifting tax liabilities to lower income brackets, the optimal tax system adversely affects other demographic groups, including low-education married parents. These results highlight the interaction between tax and child benefit policies: optimizing the tax system, even if beneficial on average, risks undermining the objectives of child benefit programs.

The second experiment maintains the baseline tax progressivity ($\tau = 0.2$) while optimizing the child benefit system. The results indicate that an optimal reform in this setting involves removing means-testing from the lump-sum child benefit program (FTB). Instead, a universal lump-sum child benefit set at 25% of the 2018 average income (approximately AUD 15,000) proves optimal. By addressing the child care costs and consumption penalties faced by parent households, this scheme generates significant welfare improvements, driven largely by gains among low-education single mothers. Ex-ante welfare increases by 7.39%, several

³All other behavioral, technology, and policy parameters are held constant at their initial steady-state values.

⁴[Tran and Zakariyya \(2021a\)](#) provide a comprehensive study of tax progressivity in Australia, including historical estimates of τ .

⁵In this framework, low-education single mothers, who lack access to family insurance (spousal earnings) and face credit constraints (due to a no-borrowing assumption), rely heavily on self-insurance through labor supply and savings. Consequently, reforms that alleviate these households' self-insurance constraints enable them to work longer hours, earn more, and consume more, especially during younger years when wealth accumulation is limited. These improvements generate substantial welfare gains for this group, which outweigh the welfare losses experienced by other households, thus leading to an overall welfare increase.

times the gains achieved under the optimal tax regime. However, while parents benefit considerably, the reform exacerbates welfare losses for non-parent households due to the higher overall tax burden, raising equity concerns.

The third experiment assesses whether a joint design—optimizing both tax progressivity (τ) and the universal child benefit payment (\bar{tr})—can deliver superior aggregate and distributional outcomes. The findings reveal that the joint optimal system integrates features of the individual optimal reforms, combining reduced tax progressivity ($\tau^* = 0.1$) with a universal lump-sum child benefit set at 30% of the 2018 average income (around AUD 18,000 per child). This amount is over 1.5 times the maximum benefit and nearly three times the average benefit per child under the baseline FTB program. In this regime, the tax reform favors high-education households at the expense of low-education parents, who bear higher tax burdens in lower income brackets. To mitigate these effects, the joint optimal system increases transfers to parents by an additional 5 percentage points (pp) relative to the standalone optimal child benefit reform. The resulting overall and parental welfare improvements surpass those under the individual reforms, underscoring the critical role of policy coordination. However, the joint design generates even larger welfare losses for non-parent households, who not only face higher tax liabilities in lower income brackets due to the tax reform but also bear a greater overall tax burden to fund the larger universal child benefits introduced by the transfer reform.

The counterfactual analyses provide several key insights. First, an income-focused optimal tax policy results in moderate overall welfare gains but undermines the objectives of child benefit programs. To reconcile these goals, a joint optimal design incorporates generous universal transfers to compensate low-income parents for their increased tax liabilities resulting from reduced tax progressivity that mainly benefits high-education parents. These findings demonstrate the importance of policy coordination.

Second, in this model, where parents constitute the majority and face unique child-related costs, utilitarian social welfare maximization favors policies that primarily benefit parents, even when they disadvantage the minority non-parent households.⁶ Non-parent households incur welfare losses under all reforms, with the largest losses occurring under the joint optimal reform, highlighting the equity trade-offs involved in optimizing for overall welfare.

Third, ensuring fiscal sustainability by balancing child benefits with broader fiscal pressures is crucial. Excessive transfers can impose tax burdens that outweigh their welfare benefits, ultimately harming both general taxpayers and the intended beneficiaries. Conversely, a less generous transfer scheme, while offering smaller gains, imposes lower costs on non-parents and may be more viable depending on the policy context.

Lastly, the analysis emphasizes the vulnerability of low-education parents, especially single mothers, to policy reforms. Structural constraints—such as limited family insurance, child-related costs, and lack of access to credit—make this group highly susceptible to welfare changes as policy environments evolve. In many experiments, the welfare outcomes of low-education single mothers are pivotal in shaping the overall post-reform welfare, making it essential to explicitly consider their well-being in policy design.

Related literature. This paper draws upon the foundation established by seminal works of [Mirrlees \(1971\)](#), [Diamond \(1998\)](#), and [Saez \(2001\)](#) on the optimal design of non-linear income tax systems, balancing efficiency and equity. [Mirrlees \(1971\)](#) shows that the marginal tax rate (MTR) schedule should exhibit an inverted U-shape. [Diamond \(1998\)](#) and [Saez \(2001\)](#) advocate for a U-shaped MTR schedule as an efficient means for income redistribution. A more recent contribution by [Ferriere et al. \(2023\)](#) extends this dialogue by proposing a U-shaped effective marginal tax rate (EMTR) schedule and higher joint progressivity for combined tax and transfer systems in the U.S.

This paper also relates to a strand of literature on female labor supply and fiscal reforms (e.g., [Baker et al. 2008](#); [Guner et al. 2012a,b](#); [Bick 2016](#); [Bick and Fuchs-Schündeln 2018](#); [Borella et al. 2018, 2020, 2022, 2023](#); [Tin and Tran 2024](#), among others). [Guner et al. \(2012a,b\)](#) analyze the disincentive effects of joint taxation

⁶Child-related costs include explicit costs, such as time and monetary commitments, and implicit costs from reduced per capita consumption in larger households. All else being equal, parent households experience lower per capita consumption and higher marginal utilities of consumption compared to their childless counterparts.

in the U.S. on female labor supply. Recent developments also delve into marriage-related social security (e.g., [Kaygusuz 2015](#); [Nishiyama 2019](#); [Borella et al. 2020](#)) and child benefits (e.g., [Guner et al. 2020](#) for the U.S. and [Tin and Tran 2024](#) for Australia). [Borella et al. 2018, 2020, 2022, 2023](#) emphasize the importance of family structure in quantitative evaluations of policy reforms. [Tin and Tran \(2024\)](#) similarly show that accounting for single mothers and their constraints can significantly influence child-related transfer policy recommendations in Australia. These findings motivate the modeling of family composition in this study.

In particular, the current model synthesizes insights from [Guner et al. \(2020\)](#), [Borella et al. \(2023\)](#), [Ferriere et al. \(2023\)](#), and [Tin and Tran \(2024\)](#). Methodologically, it extends the framework of [Tin and Tran \(2024\)](#) by endogenizing female participation and work-hour decisions while retaining rich household heterogeneity, exploring the joint design of tax and child benefit systems, proposing an optimal system, and decomposing post-reform welfare changes to identify their driving forces.

The study also contributes to the broader literature on means-tested social insurance (e.g., [Feldstein 1987](#); [Hubbard et al. 1995](#); [Neumark and Powers 2000](#); [Tran and Woodland 2014](#); [Braun et al. 2017](#)). While this literature generally shows that means-testing can distort incentives to work and save, it also shows that it can balance the trade-off between insurance and incentives to improve welfare. In contexts where means-testing rules are complex and parents face child-related costs and consumption penalties, the findings here suggest that universal lump-sum transfers may enhance overall welfare but come with equity trade-offs.

Additionally, [Keane \(2022\)](#) highlights that the frontier of optimal tax research involves dynamic stochastic general equilibrium models with overlapping generations of heterogeneous workers, incorporating endogenous wages, participation decisions, educational differences, and family structure. While many studies address subsets of these elements, [Keane \(2022\)](#) notes that none have tackled all of them simultaneously. Thus, by fully integrating these elements and allowing for extensive household heterogeneity in a dynamic general equilibrium overlapping generations environment, the framework I employ adds to the quantitative development of the optimal tax and transfer literature.⁷ It also fills a gap in the structural modeling of taxes and child benefits in Australia.

Lastly, by investigating the implications of the proposed optimal tax and child benefit systems on female labor supply in Australia, this paper complements empirical research on labor supply (e.g., [Doiron and Kalb 2005](#); [Gong and Breunig 2017](#); [Hérault and Kalb 2022](#); [Tran and Zakariyya 2022](#); [Tin and Tran 2023](#)) and contributes to the growing body of quantitative studies on fiscal policies in Australia (e.g., [Tran and Woodland 2014](#), [Iskhakov and Keane 2021](#), [Kudrna et al. 2022](#), and [Tin and Tran 2024](#)).

The paper hereinafter proceeds as follows. Section 2 presents stylized facts. Section 3 introduces a simple analytical model for intuition. Section 4 describes the quantitative model. Section 5 reports the calibration procedures and evaluates the benchmark model’s performance. Section 6 discusses the main results Section 7 concludes. The Appendix provides supplementary results and statistics, details on the Australian child benefit programs, and the algorithm used to solve the model.

2 Income taxes and child benefits in Australia

This section outlines the key institutional features of Australia’s child benefit programs and presents selected empirical facts, including simulated effective marginal tax rate (EMTR) schedules, based on data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey, Restricted Release 20 (2001-2020). These serve as the empirical foundation for the subsequent quantitative analyses. Unless otherwise stated, all monetary values are expressed in 2018 Australian dollars (AUD).

⁷[Conesa et al. 2009](#) treat hours worked as a choice variable but not labor force participation. [Blundell et al. 2016](#) model the interaction between tax and child benefit systems within a dynamic life cycle model of female labor supply, human capital formation, and savings to identify optimal policy mixes, but abstract from family structure. [Guner et al. \(2020\)](#) include all key elements to study tax and welfare systems in the U.S. but do not focus on optimality. This paper aligns more closely with recent works, such as [Guner et al. 2023](#), which addresses a broad set of means-tested transfers for working-age households in the U.S. However, while their study mainly considers alternative policies for welfare improvements, my focus is on assessing and jointly optimizing taxes and child benefits using the Australian policy context.

2.1 Joint effects on progressivity

Progressive income taxes

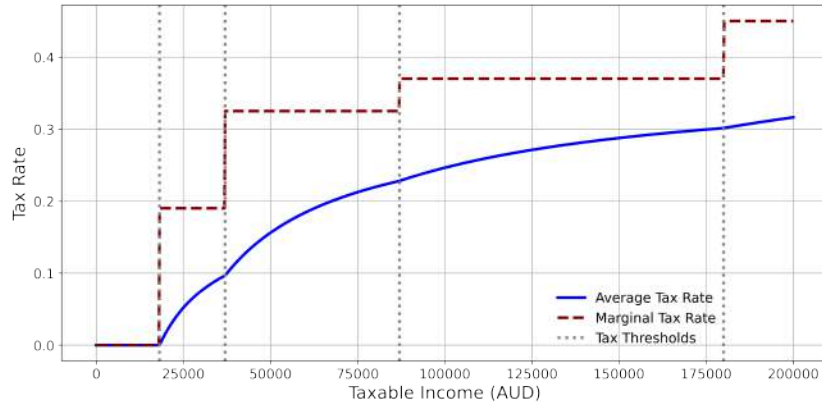


Figure 1: Marginal and average tax rate schedules in Australia in 2018.

In Australia, labor and capital income are taxed on an individual basis, while social security benefits are means-tested based on family income. The statutory income tax schedules in 2018, illustrated in Figure 1, are progressive. While a single individual earning around the poverty line of AUD 27,364 faces a marginal tax rate (MTR) of 19%, her average tax rate (ATR) is only 5% due to the zero-tax income zone that extends to AUD 18,200.⁸

The MTR rises further to 32.5% for workers earning above the second threshold of AUD 37,000, and eventually reaches 45% for those in the top threshold. Nonetheless, as a result of the progressive tax structure, average income earners in Australia (earning approximately 60,000 AUD) face an average tax rate of only 20%. [Tran and Zakariyya 2021a](#) provides a comprehensive analysis of the Australian tax system, including historical estimates of progressivity indicators, which suggest that the Australian tax system is relatively more progressive than the U.S. tax system.⁹

Means-tested child benefits

Family assistance payments are a significant component of Australia’s benefit programs, constituting approximately 22% of total public transfers (or 2% of GDP) over the past two decades, second only to pensions, which account for 56%. While the Age Pension dominates pension expenditures, family payments are the primary transfer mechanism for working-age parents and play a pivotal role in redistribution. Within the family assistance category, two means-tested child benefit programs—the Family Tax Benefit (FTB) and Child Care Subsidy (CCS)—are central, accounting for 70% of total family payments, according to the [2018-19 budget report](#).¹⁰

The FTB comprises two components: FTB Part A (FTB-A) and FTB Part B (FTB-B). Both provide direct lump-sum transfers to support low-income families with dependent children. Their means-testing parameters—including payment amounts, income thresholds, and phase-out rates—vary based on demographic factors such as marital status and the number and age of children. The main distinctions lie in their size and the income definitions used for means-testing. FTB-A, the larger component in terms of both payment and coverage, is

⁸See [ABS’ average weekly earnings report](#) for average weekly earnings figures, and [Melbourne Insitute’s poverty lines report](#) for definition and estimates of poverty lines in Australia in 2018.

⁹For example, [CRS overview of the Federal Tax System in 2018](#) indicates that the U.S. federal income tax schedule has no zero-tax zone. It begins with a 10% MTR for single tax filers earning between 0 to 9,525 USD. Those with income between 82,501 to 157,500 USD face a 24% MTR, whereas in Australia, taxpayers in the same income range would fall into the fourth or fifth brackets, facing an MTR of at least 37%. This comparison excludes tax offsets and concessions, such as the Low-Income Tax Offset (LITO) in Australia and the Earned Income Tax Credit (EITC) in the U.S.

¹⁰This study excludes the Paid Parental Leave program, which represents a smaller share of family assistance expenditure.

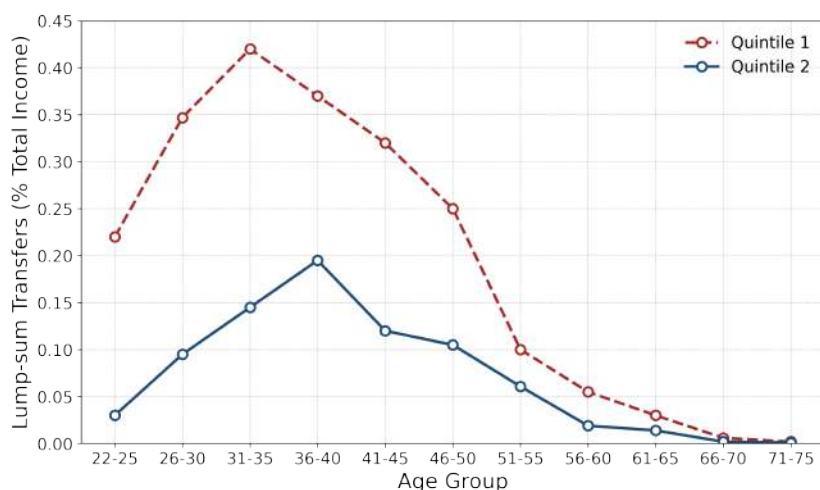


Figure 2: Age profiles of FTB share of gross household income for the lower two family income quintiles in 2018.

paid per child and is means-tested on combined family income. In contrast, FTB-B is paid per household and aims to provide additional support to single parents and single-earner families. Eligibility for FTB-B is determined by the primary earner's income, with payments adjusted according to the secondary earner's income.

Despite some differences, both transfers are generous and highly progressive. As depicted in Figure 2, average FTB benefits account for up to 40% of gross income for households in the first quintile and 20% for those in the second quintile during child-bearing and rearing years.

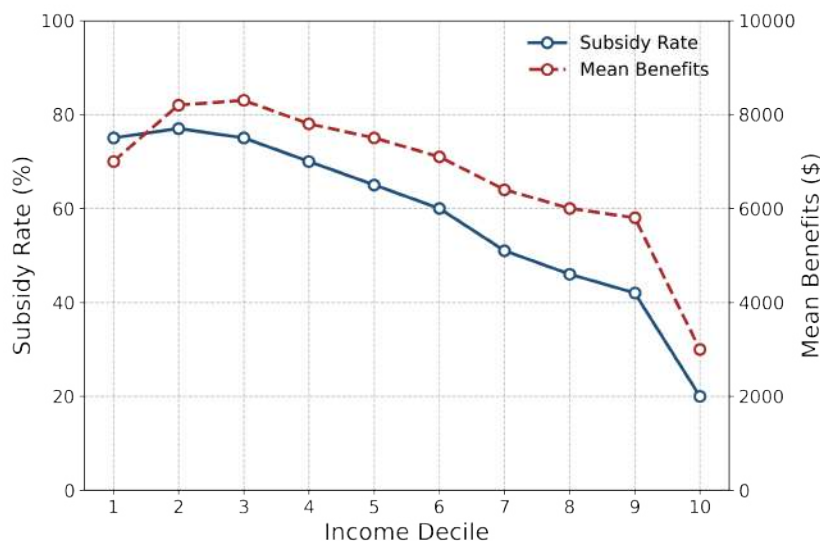


Figure 3: Effective Child Care Subsidy rates and Mean Benefits (Subsidies) by income decile.

Notes: This figure uses data from Table 61 in the 2021 report by the AIFS. The lowest decile earned at most \$31,399. The top decile earned \$240,818 or more.

The CCS subsidizes formal child care costs for children up to 13 years of age. Like the FTB, the base subsidy rate is determined by means-testing family income. However, its distinguishing feature is the activity test, which adjust the base subsidies based on the secondary earner's work hours. In 2018, low-income parent households with secondary earners working 48 hours or more per fortnight could receive a base (statutory) subsidy rate of up to 85% on their formal child care costs.¹¹

¹¹In this paper, only labor supply is considered for the CCS activity test. In practice, households with secondary earners engaged in recognized activities—such as employment, training, or volunteering—for 48 hours or more per fortnight are eligible for the full base subsidy.

Figure 3 shows the progressivity of the means-tested CCS: parent households below the median income receive 70-75% subsidies on child care costs, with benefits hovering around AUD 8,000. Subsidies are smaller for the bottom decile due to adjustments based on work hours. Nonetheless, the means-testing mechanism ensures a progressive subsidy schedule that declines with rising income.

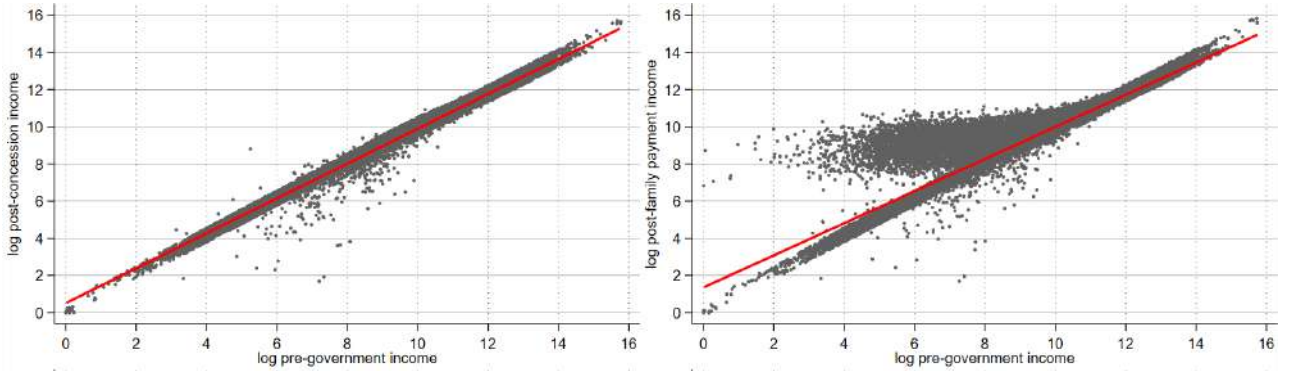


Figure 4: **Log post-concession income (left panel) and log post-family-payment income (right panel) by log pre-government income level.**

Notes: Pre-government income includes regular private market income and private transfers (excluding irregular flows such as severance payment and irregular private transfers). Post-concession income refers to private income after tax and concessions. Post-family-payment income is the sum of post-concession income and family payment (public transfers to family).

Furthermore, the FTB and CCS are not mutually exclusive. Each program delivers substantial benefits, averaging between AUD 8,000 and AUD 10,000, to approximately one million families—over 40% of families with children under 16 years old. Detailed descriptions and related statistics for these programs are provided in the Appendix and in [Tin and Tran \(2024\)](#).¹²

Joint progressivity

The means-tested child benefit programs, in conjunction with the progressive tax regime, result in a strong redistributive effect. As evident in Figure 4, a comparison of log pre-government income with log post-family-payment income (right panel) reveals a flatter fitted line than that for log post-concession income (i.e., post-tax-and-concession). This effect is driven by a large cluster of observations above the 45-degree line for the former case, indicating that average post-family-payment income for working parents in lower income brackets significantly exceeds their post-tax-and-concessions income. This joint progressivity is a defining characteristic of the combined tax and child benefit systems.¹³

2.2 Joint effects on effective marginal tax rate (EMTR)

The second defining characteristic of the joint tax and child benefit systems is their interplay, which significantly increases the effective marginal tax rate (EMTR) for beneficiaries. That is, their interaction raises the total marginal cost of earning labor income beyond what a single program could impose. Since means-testing is based on family income, this effect is particularly pronounced for secondary earners, most of whom are women with family incomes in the benefit phase-out zones.

To illustrate this impact, I simulate the EMTR schedules for three types of low-education young mothers, differing only in marital status and spousal earnings. The simulation is based on the actual child benefit

¹²More precisely, as of June 2018, 1.4 million families were receiving FTB payments, 77% of whom were eligible for both FTB-A and FTB-B ([AIHW report 2022](#)). In the December quarter of 2018, the CCS supported 974,600 families ([Child Care in Australia report 2018](#)). Estimates of average benefits in this study are based on HILDA survey data. For the FTB, the [APH report on Social security and family assistance](#) reports total expenses of approximately AUD 17 billion in 2018. Given the 1.4 million recipients, this translates to a higher annual average payment of AUD 12,000 per family compared to my estimates. The discrepancy may arise from the broader definition of family assistance, which likely includes Paid Parental Leave, excluded from my analysis.

¹³The log transformation excludes transfers to individuals with zero or negative pre-government income, which should be considered when interpreting these results. Their inclusion should make the right panel's line flatter.

program structure in 2018, as detailed in Appendix Section H.3. To fully capture the work disincentives faced by women, consistent with the quantitative model environment, all EMTR schedules account for marginal child care costs, both with and without child care subsidies.

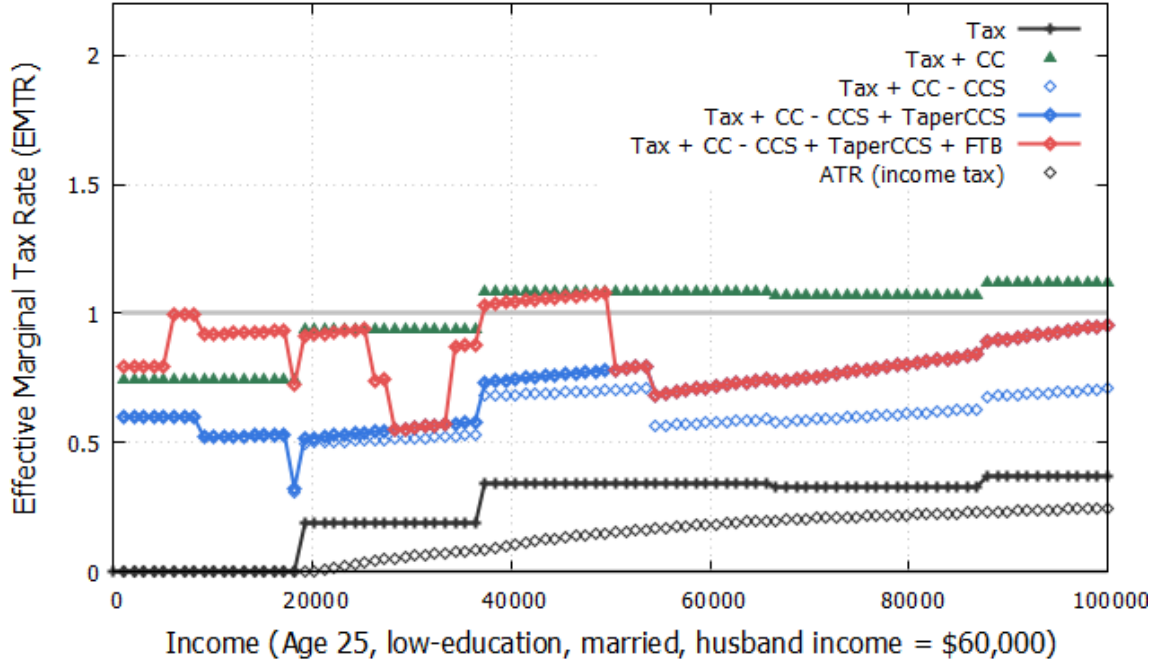


Figure 5: **Effective Marginal Tax Rate (EMTR) schedule for a low-education (high school or below) young mother with two children:** Married with husband earning AUD 60,000.

Notes: These lines show the cumulative effects, stacked successively. The black dotted line is the average income tax rate (ATR). The black solid line is the marginal tax rate (MTR), including Low Income Tax Offset (LITO). The dotted green line is the EMTR when the marginal rate of the gross child care cost (CC) is added on top of the MTR. The light dotted blue line is the EMTR that incorporates the base subsidy rates of the CCS. The heavy solid blue line accounts for both the base subsidies and phase-out rates of the CCS. The solid red line is the total EMTR schedule when the FTB's phase-out rates are included.

Figure 5 presents the simulated EMTR schedule for a 25-year-old low-education mother of two children whose husband earns the average income. Her total EMTR (red line) ranges between 70% and 100% across income levels.¹⁴ Even in the absence of taxes and transfers, her labor supply is constrained by child care costs. While her marginal tax rate (MTR, black solid line) never exceeds 40%, formal child care fees raise her pre-transfer EMTR (green line) to the point where she incurs a net loss for every dollar earned beyond the second tax threshold of AUD 37,000.¹⁵

Means-tested child benefits introduce complex interactions that further complicate her EMTR schedule. At lower earnings (below AUD 50,000), while the means-tested CCS (heavy-blue line) substantially reduces her EMTR, the FTB phase-outs counteract this reduction, pushing her EMTR back up to approximately 100% (red line).¹⁶ Consequently, in the low-income bracket where tax distortions are minimal, the FTB's means-testing acts as an implicit tax, increasing the mother's EMTR. As her earnings grow, the FTB phases out, reducing its distortions. However, this is offset by the combination of increasing MTRs and the phase-out rates of the CCS, which keep her EMTR elevated. Once her income exceeds AUD 50,000, the CCS phase-out and MTR simply replace the FTB phase-out as the dominant factors. Therefore, the interaction between these programs creates a high, non-linear, and non-monotonic EMTR schedule for recipients, with different elements dominating at

¹⁴A formal expression of the EMTR is provided in Equation (51) in Subsection 4.7.

¹⁵In the simulation, hourly child care fees are fixed at AUD 12.50/hour, which constitutes a significant fraction of a low-education mother's hourly wage, thus explaining the sharp rise in her pre-transfer EMTR schedule (green line). For high-education mothers, child care costs have a weaker impact on their EMTR schedules.

¹⁶In fact, the CCS without means-testing (light-blue line) would have a stronger EMTR reduction effect, particularly at higher income levels, though weaker at lower incomes due to the work hour test. However, because the CCS is means-tested, its phase-out rate adds to the EMTR (raising it from the light-blue to heavy-blue line), diluting the intended work incentive effects as earnings increase.

various income levels.

In addition, EMTR schedules differ across demographic and socioeconomic groups. As shown in the left panel of Figure 6, a woman with identical demographic traits to her counterpart in Figure 4, except with a partner earning twice as much (AUD 120,000), experiences a different EMTR schedule. Her husband's high earnings exceed the FTB income-test thresholds, eliminating its phase-out effect (heavy-blue and red lines overlap). However, she continues to face high EMTRs due to the phase-out of child care subsidies.

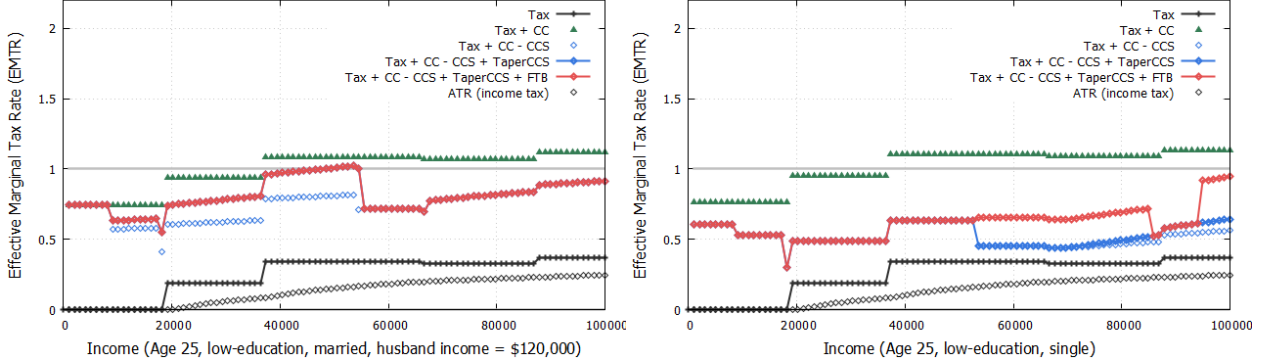


Figure 6: **Effective Marginal Tax Rate (EMTR) schedule for a low-education (high school or below) young mother with two children: Left Panel—Married with husband earning AUD 120,000; Right Panel—Single mother.**

Notes:

(*) These lines show the cumulative effects, stacked successively. The black dotted line is the average income tax rate (ATR). The black solid line is the marginal tax rate (MTR), including Low Income Tax Offset (LITO). The dotted green line is the EMTR when the marginal rate of the gross child care cost (CC) is added on top of the MTR. The light dotted blue line is the EMTR that incorporates the base subsidy rates of the CCS. The heavy solid blue line accounts for both the base subsidies and phase-out rates of the CCS. The solid red line is the total EMTR schedule when the FTB's phase-out rates are included;

(**) On the left panel, note how the red line (total EMTR) overlaps the blue line (EMTR without FTB). This suggests that the FTB phase-out rate has no effect on the EMTR.

Conversely, the right panel of Figure 6 illustrates the case of a single mother with the same age, education, and number of children. Since her family income consists solely of her earnings, the FTB phase-out does not begin until her income crosses the first income-test threshold of AUD 52,706 (for the maximum FTB payment). She also benefits from the full CCS rate, which only begins tapering at earnings above AUD 70,000.¹⁷ Her total EMTR generally hovers around 60%, lower than that of her married counterpart. However, as her income rises, the combination of higher MTRs and child benefit (FTB and CCS) phase-outs gradually pushes her EMTR to nearly 100%. Regardless, holding all other demographic and socioeconomic factors constant, a low-income single mother generally faces lower EMTR compared to her married counterpart. These findings demonstrate that means-testing based on family income creates differing distortions depending on marital status and spousal earnings.

The simulated case studies underscore the role of taxes and means-tested child benefits in generating high progressivity. They also emphasize the significant impact of policy interactions on the EMTR schedules faced by beneficiaries, particularly women.¹⁸ In summary, the interplay between progressive taxes and means-tested child benefits brings about three key effects: (i) strong redistribution; (ii) persistently high, non-linear, and non-monotonic EMTR schedules; and (iii) varying EMTR schedules across socioeconomic and demographic groups.

These empirical findings warrant an investigation into the optimal joint design of taxes and child benefits, including their impacts on overall welfare, distribution, and key macroeconomic indicators such as female labor supply and output.

¹⁷For a single mother earning below AUD 50,000, taxes and child care costs increase her EMTR schedule, but the CCS reduces it. In this range, the FTB phase-out is inactive, resulting in an overlap between the heavy-blue line (EMTR without FTB) and the red line (EMTR with FTB).

¹⁸Further discussion on EMTR variations over the parental life cycle is available in Subsection A.2 of the Appendix.

3 A simple model

In this section, I formulate a simple static model of a representative parent household making consumption and female labor supply decisions within a general equilibrium environment. In this setup, the mother faces formal child care costs if she works, and income tax is used to balance the public budget.

First, the model illustrates how means-tested benefits and work subsidies—central features of the current child benefit system—interact to influence female labor supply, household consumption, and overall welfare. Second, it demonstrates that, even in the presence of child care costs, the optimal outcome corresponds to a distortion-free economy. In other words, in the current Australian economy, where distortions from means-testing and progressive taxes are prevalent, the optimal policy is to eliminate these distortions. This could be achieved by removing transfers entirely, eliminating means-testing, or introducing counter-programs to offset existing distortions. However, this result overlooks the distributional, insurance, and fiscal control functions of means-tested benefits in more realistic settings where households are heterogeneous and face uninsurable income shocks. These aspects are addressed in the quantitative framework in Subsection 4.

Representative parent household

Consider a married parent household making static decisions on consumption c and female labor supply n to maximize joint utility, subject to a budget constraint. The husband's labor supply n_m is perfectly inelastic and earns a unit wage rate, with income taxed at a rate τ .

To derive a closed-form solution, I focus on the role of taxation as a government budget-balancing tool and abstract from its distortionary effects on female labor supply. Specifically, suppose the mother's labor supply n falls within a tax-free zone but incurs a child care cost κ .

The government aims to encourage female labor supply by offsetting κ . Thus, the child care costs are subsidized at a rate s , emulating the Child Care Subsidy (CCS) that supports secondary earners. In addition, to reflect policies targeting low-income parents, assume further that the household may qualify for a means-tested child benefit (FTB) if its income falls below a certain threshold.

The household's utility function is denoted as $u(c, 1 - n)$, satisfying standard properties of well-behaved utility functions: $u' > 0$, $u'' < 0$, $\lim_{x \rightarrow 0} u' = \infty$, $\lim_{x \rightarrow \infty} u' = 0$, for all arguments $x \in \{c, 1 - n\}$. The household's optimization problem is:

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

subject to

$$c = (1 - \tau)n_m + (1 - \overbrace{(\kappa - s)}^{\text{Net child care cost}})n + \overbrace{FTB(n)}^{\text{Means-tested transfer}} \quad (2)$$

where $FTB(n) = \max\{\min\{\bar{tr}, \bar{tr} - \omega(n_m + n - \bar{y})\}, 0\}$, with \bar{tr} denoting the maximum payment, ω the phase-out rate, and \bar{y} the family-income test threshold.

Representative firm

The single firm in the economy employs a basic technology that transforms labor linearly into output y . The firm does not differentiate between male and female labor, paying all workers at a unit wage rate, $w = 1$. The total output is given by:

$$y = n_m + n$$

Government

The government balances its budget by collecting income tax τn_m to fund general expenditures G and total transfers $sn + \bar{t}r - \omega(n_m + n - \bar{y})$. The government's budget equation is:

$$\tau n_m = G + sn + \bar{t}r - \omega(n_m + n - \bar{y})$$

Since n_m is perfectly inelastic, τn_m is effectively a lump-sum tax. For simplicity, assume that the household derives no benefit from G .

3.1 First- and second-best allocations of female labor supply

To examine the welfare implications of the setup, I compare it with a first-best economy (without distortions). For this purpose, I first reformulate the household problem and government budget equation by assuming the only policy is a lump-sum tax T . Next, I derive distortion-free optimal labor supply (n^*) and consumption (c^*)—the *first-best allocations*—and their corresponding baseline efficiency and welfare measures.

The household problem is rewritten as:

$$\max_{c, n} \{u(c, 1 - n)\} \quad (3)$$

subject to

$$c = n_m + (1 - \kappa)n - T \quad (4)$$

The government budget equation simplifies to:

$$T = G \quad (5)$$

The optimal consumption-leisure trade-off condition is:

$$MRS_{c, 1-n} = \frac{u'_c}{u'_{1-n}} = \frac{1}{1 - \kappa} \quad (6)$$

Assuming Cobb-Douglas, $u(c, 1 - n) = c^\nu (1 - n)^{1-\nu}$, where $0 < \nu < 1$ is the taste-for-consumption parameter, the interdependence between c and n arises through preference and the budget constraint. Using the optimality condition (6) and the budget constraint (4), the first-best (female) labor and consumption allocations are:

$$n^* = \nu - \frac{1 - \nu}{1 - \kappa}(n_m - G^*) \quad (7)$$

$$c^* = \nu(1 - \kappa + n_m - G^*) \quad (8)$$

where G^* denotes distortion-free government spending. Equations (7) and (8) show that n^* and c^* are both increasing functions in ν . The exogenous male income n_m is a positive income effect (*IE*) that reduces n^* and increases c^* , whereas G^* , a negative *IE*, does the opposite. While there is no distortionary tax in this economy, κ acts as a tax by nature on the mother's labor supply, causing n^* and c^* to fall.

Aggregate output is:

$$y^* = n_m + n^* \quad (9)$$

The first-best utility (welfare) is obtained by substituting (7) and (8) into the Cobb-Douglas utility function. Thus, the associated household utility, expressed in log form for comparison with second-best outcomes, is:

$$\ln(u^*) = \nu \ln(\nu) + (1 - \nu) \ln(1 - \nu) + \underbrace{\ln(1 - \kappa + n_m - G^*)}_{(a) \text{ Income effects}} - \underbrace{(1 - \nu) \log(1 - \kappa)}_{(b) \text{ Effect of } \kappa \text{ on leisure}} \quad (10)$$

where $u^* := u(c^*, 1 - n^*)$; Term (a) reflects the positive welfare effects of n_m and the negative effects of κ and G^* ; Term (b) captures the direct utility impact of κ through its influence on leisure.¹⁹

3.1.1 Second-best economy with means-tested child benefits

Means-testing introduces wage distortions, causing deviations from the first-best allocations (7) and (8). To understand the implications of such departures, consider a case where family income falls in the phase-out zone of FTB benefits.²⁰ In this scenario, the household budget constraint from Equation (2) becomes:

$$c = (1 - \tau)n_m + (1 - \kappa + s)n + \bar{t}r - \omega(n + n_m - \bar{y}) \quad (11)$$

The optimal consumption-leisure trade-off condition is:

$$MRS_{c,1-n} = \frac{u'_c}{u'_{1-n}} = \frac{1}{1 - \kappa - \omega + s} \quad (12)$$

The government budget-clearing tax rate is:

$$\tau = \frac{G + sn + \bar{t}r - \omega(n_m + n - \bar{y})}{n_m} \quad (13)$$

Using the Cobb-Douglas utility for (12), together with the household budget constraint (11) and the government budget-clearing tax rate (13), the second-best allocations for labor and consumption are:

$$n_\omega = \frac{\nu(1 - \kappa - \omega + s) - (1 - \nu)(n_m - G)}{1 - \kappa - \nu(\omega - s)} \quad (14)$$

$$c_\omega = \frac{\nu(1 - \kappa - \omega + s)(1 - \kappa + n_m - G)}{1 - \kappa - \nu(\omega - s)} \quad (15)$$

Aggregate output is:

$$y_\omega = n_m + n_\omega$$

Using (14) and (15), together with the first-best allocations (7) and (8), the relationships between the second-best and first-best allocations are:

$$n_\omega(n^*) = \frac{(1 - \kappa)n^* - \nu(\omega - s) + (1 - \nu)(G - G^*)}{1 - \kappa - \nu(\omega - s)} \quad (16)$$

$$c_\omega(c^*) = \frac{(1 - \kappa - \omega + s)[c^* - \nu(G - G^*)]}{1 - \kappa - \nu(\omega - s)} \quad (17)$$

I assume that $G = G^*$, meaning the government maintains the same level of general (non-transfer) spending as in the first-best economy, these equations simplify to:

$$n_\omega(n^*) = \frac{(1 - \kappa)n^* - \nu(\omega - s)}{1 - \kappa - \nu(\omega - s)} \quad (18)$$

$$c_\omega(c^*) = \frac{(1 - \kappa - \omega + s)c^*}{1 - \kappa - \nu(\omega - s)} \quad (19)$$

The government budget-clearing tax (13) ensures that the total transfers $sn + \bar{t}r - \omega(n_m + n - \bar{y})$ are financed through an equivalent increase in τn_m . As a result, the balanced public budget requirement eliminates the direct positive IE from the transfers. Deviations from the first-best allocations, as demonstrated in Equations (18) and (19), are thus driven solely by marginal considerations.

In this setting, s (subsidy rate) and ω (phase-out rate) are the only two policy instruments influencing

¹⁹In contrast to its negative welfare effect via the household's budget constraint, κ has a direct positive utility effect by increasing leisure, which is weighted by the household's taste for leisure.

²⁰Other scenarios, in which family income lies outside the phase-out zone and female labor supply is not distorted by the transfers, can be analyzed by setting $\omega = 0$. However, these scenarios are not considered here.

second-best allocations. Their effects are as follows:

$$\frac{\partial n_\omega}{\partial s} = \frac{\nu(1-\kappa)(1-n^*)}{(1-\kappa-\nu(\omega-s))^2} > 0 \quad ; \quad \frac{\partial n_\omega}{\partial \omega} = -\frac{\nu(1-\kappa)(1-n^*)}{(1-\kappa-\nu(\omega-s))^2} < 0 \quad (20)$$

$$\frac{\partial c_\omega}{\partial s} = \frac{(1-\nu)(1-\kappa)c^*}{(1-\kappa-\nu(\omega-s))^2} > 0 \quad ; \quad \frac{\partial c_\omega}{\partial \omega} = -\frac{(1-\nu)(1-\kappa)c^*}{(1-\kappa-\nu(\omega-s))^2} < 0 \quad (21)$$

For $1-\kappa-\nu(\omega-s) \neq 0$, both n_ω and c_ω increase as the s increases or ω decreases. Consequently, economic output ($y_\omega = n_m + n_\omega$) also rises with a higher s or a lower ω .²¹

3.1.2 Welfare analysis

The second-best welfare measure is derived by substituting (14) and (15) into the Cobb-Douglas utility function. In logarithmic form:

$$\begin{aligned} \ln(u_\omega) &= \nu \ln(\nu) + (1-\nu) \ln(1-\nu) \\ &\quad + \ln(1-\kappa+n_m-G) + \nu \ln(1-\kappa-\omega+s) - \ln(1-\kappa-\nu(\omega-s)) \end{aligned} \quad (22)$$

The gap between the first-best (10) and the second-best (22) welfare measures is expressed as:

$$\underbrace{\ln(u_\omega) - \ln(u^*)}_{\text{Welfare gap } (\Delta u)} = \underbrace{\ln(1-\kappa+n_m-G) - \ln(1-\kappa+n_m-G^*)}_{(a) \text{ Relative strength of IE}} \quad (23)$$

$$+ \underbrace{\nu \ln(1-\kappa-\omega+s) + (1-\nu) \ln(1-\kappa) - \ln(1-\kappa-\nu(\omega-s))}_{(b) \text{ Effects of wage distortions}} \quad (24)$$

$G = G^*$ as per assumption above, and the expression simplifies to:

$$\Delta u = \underbrace{\nu \ln(1-\kappa-\omega+s) + (1-\nu) \ln(1-\kappa) - \ln(1-\kappa-\nu(\omega-s))}_{(b) \text{ Effects of wage distortions}} \quad (25)$$

The only policy tools that influence the welfare gap (Δu) are the subsidy rate s and the phase-out rate ω . The first derivatives of Δu with respect to s and ω are:

$$\frac{\partial \Delta u}{\partial s} = \frac{\nu}{1-\kappa-(\omega-s)} - \frac{\nu}{1-\kappa-\nu(\omega-s)} \quad (26)$$

$$\frac{\partial \Delta u}{\partial \omega} = \frac{\nu}{1-\kappa-\nu(\omega-s)} - \frac{\nu}{1-\kappa-(\omega-s)} \quad (27)$$

Since $0 < \nu < 1$, the sign of the derivatives depends on $\omega - s$.

$$\text{If } \omega - s > 0 : \frac{\partial \Delta u}{\partial s} > 0 \quad \text{and} \quad \frac{\partial \Delta u}{\partial \omega} < 0 \quad (28)$$

$$\text{If } \omega - s = 0 : \frac{\partial \Delta u}{\partial s} = 0 \quad \text{and} \quad \frac{\partial \Delta u}{\partial \omega} = 0 \quad (29)$$

$$\text{If } \omega - s < 0 : \frac{\partial \Delta u}{\partial s} < 0 \quad \text{and} \quad \frac{\partial \Delta u}{\partial \omega} > 0 \quad (30)$$

These conditions highlight the importance of policy interactions. The optimal reform depends on the existing policy mix, particularly the relative dominance of the benefit phase-out rate ω and the subsidy rate s .

If the current policy is such that $\omega > s$, as in (28), increasing s or reducing ω enhances the second-best welfare u_ω relative to the first-best u^* . Conversely, if $s > \omega$, as in (30), the reverse holds. When $\omega = s$, as in (29), the marginal welfare effect from any reform is nil. In other words, the first-best welfare u^* represents the maximum welfare attainable.

This result underscores an important insight: *wage distortions, $|\omega - s|$, in either direction are welfare-deteriorating.*²² Starting from the first-best economy, provided that the tax burden from transfers is fully borne

²¹Note too that $\frac{\partial x}{\partial s} = -\frac{\partial x}{\partial \omega}$ for $x \in \{n_\omega, c_\omega\}$, indicating symmetric effects of s and ω on labor supply and consumption.

²²Because the model is homogeneous in households and deterministic in the earnings process, welfare improvements must stem

by the recipients, further welfare improvements are not possible. Otherwise, a policy reform that minimizes distortions is always welfare-improving. The optimal policy thus arises in two scenarios: (i) the first-best economy, where all tax and transfer policies are lump sum, such that $\omega = s = 0$, or (ii) an alternative economy where policies perfectly counteract each other, such that $|\omega - s| = 0$.

The welfare perspective contrasts sharply with labor, consumption, and output outcomes. Equation (18) and its first derivatives (20) indicate that these variables can exceed their first-best levels by raising s relative to ω , albeit at a welfare cost as higher consumption and output necessitate more labor and therefore less leisure.²³

Assuming output serves as a proxy for efficiency, these results suggest that efficiency-welfare trade-offs emerge when policies that improve output exacerbate wage distortions, $|\omega - s|$. However, it also implies that in the current Australian environment, where $|\omega - s| > 0$ (as evident in the simulated EMTR schedule in Figure 5 of Section 2), policies improving both efficiency and welfare are possible. For instance, reducing ω or increasing s can promote labor supply and output while enhancing welfare by mitigating existing wage distortions.²⁴

In summary, these analytical findings highlight three key lessons that inform the quantitative framework in Section 4. First, they emphasize *the interplay between policies*. A welfare policy's implications depend on its interaction with other policies, including the tax system. Ignoring these interactions may alter the conclusions of counterfactual reforms, potentially skewing policy recommendations.

Second, even in the absence of tax distortions, the findings emphasize *the pivotal role of funding mechanisms for transfers*. In a partial equilibrium environment, where the financial needs of child benefit programs are not taken into account, their welfare contributions may be overstated. A comprehensive investigation must consider the general equilibrium effects via the tax channel, as tax burdens can counteract the positive effects of transfers.

Third, this analysis is limited by its omission of the redistributive and insurance roles of child benefits. The theoretical model is built on a representative-agent foundation, where all households receive benefits and bear the corresponding tax burden. In practice, taxes and transfers are unevenly distributed. Means-tested child benefits primarily target low-income parents, whereas the burden is spread across the working-age population. Empirical evidence from Figures 5 and 6 also reveals that policy-induced EMTR schedules vary across socioeconomic and demographic groups. In addition, parent households face unique constraints—such as the monetary and time costs of child care—that non-parents do not. These factors suggest that child benefits influence welfare through their redistributive role, a mechanism not captured in this simplified model. Furthermore, as the analytical model is deterministic, it is silent on the potential welfare improvements from the insurance effect of child benefits against idiosyncratic earnings shocks. These considerations underscore *the importance of incorporating household heterogeneity and income uncertainty* in child benefit policy assessments.

Guided by these theoretical insights, I develop a structural model with four core components to analyze the joint design of taxes and child benefits. First, the model incorporates Australia's progressive tax structure and its two major child benefit programs, the FTB and CCS, to fully account for their interactions. Second, all counterfactual experiments are conducted within a general equilibrium framework, with an endogenous income tax balancing the government budget. Third, the model is built on an overlapping generations framework with heterogeneous households to capture welfare changes through redistribution across the life cycle and between demographic groups. Lastly, uninsurable earnings shocks are included to capture welfare effects through the insurance channel.

4 A dynamic general equilibrium model

I study a small open economy model populated by a continuum of overlapping generations of households, a representative firm with constant returns to scale (CRS) technology, and a government who commits to

from a more efficient allocation of consumption and leisure.

²³As $y_\omega = n_m + n_\omega$, this assumes n_m is perfectly inelastic to increased tax rates needed to finance s .

²⁴This theoretical result aligns with [Tin and Tran \(2024\)](#), who find that reducing the CCS phase-out rate improves labor supply, output, and welfare.

balancing its budget every period. Time begins at $t = 0$ when the model economy is in an initial steady state, and ends at $t = T$. One model period corresponds to one year. This model extends the structural framework established in [Tin and Tran \(2024\)](#).²⁵

4.1 Demographics

Every period t , a new cohort of households aged $j = 1$ (equivalent to real age of 21) enters the economy. Adult members of gender $i \in \{m, f\}$ in a household born at time t survive each subsequent period $t + j - 1$ with a time-invariant conditional probability $\psi_{j,i}$ and can live up to a maximum age of $J = 80$ (i.e., $\psi_{J+1,i} = 0$). Individuals begin working at $j = 1$ and retire at age $J_R = 45$. The initial total number of households at time $t = 0$ is normalized to one, and the model population grows at a constant rate, g_N .²⁶

Family structure. Households are assigned one of four family types at birth: married parents ($\lambda = 1$), married childless couples ($\lambda = 2$), single childless men ($\lambda = 3$), and single mothers ($\lambda = 4$). Married households comprise a husband and wife of identical age and education. The evolution of marital status depends solely on survival probabilities, meaning a married household becomes single if one spouse dies. Single households, on the other hand, remain single until death. The model does not account for divorce, marriage, or re-marriage after the initial assignment. Parenthood, defined as the state of having a co-resident child at any point, is a permanent status. Married childless couples ($\lambda = 2$) cannot transition to married parents ($\lambda = 1$), and vice versa. Additionally, all single women are assumed to be mothers, whereas single men are childless. Transition probabilities for family structure ($\pi_{\lambda_{j+1}|\lambda_j}$) are given by Table 1.

$\pi_{\lambda_{j+1} \lambda_j}$	$\lambda_{j+1} = 1$	$\lambda_{j+1} = 2$	$\lambda_{j+1} = 3$	$\lambda_{j+1} = 4$
$\lambda_j = 1$	$\psi_{j+1,m}\psi_{j+1,f}$	0	$\psi_{j+1,m}(1 - \psi_{j+1,f})$	$(1 - \psi_{j+1,m})\psi_{j+1,f}$
$\lambda_j = 2$	0	$\psi_{j+1,m}\psi_{j+1,f}$	$\psi_{j+1,m}(1 - \psi_{j+1,f})$	$(1 - \psi_{j+1,m})\psi_{j+1,f}$
$\lambda_j = 3$	0	0	$\psi_{j+1,m}$	0
$\lambda_j = 4$	0	0	0	$\psi_{j+1,f}$

Table 1: Transition probabilities of family structure

Children. This model abstracts from fertility choice, assuming children are exogenous and deterministic. They contribute neither to the utility of parents nor to the broader economy after reaching adulthood.²⁷ Married and single-parent households possess full information on the timing of children’s arrival, non-pecuniary and pecuniary child care costs, the FTB transfer per child, the CCS rate per hour worked, and the human capital implications of maternal labor decisions. Child care quality and costs for a child aged j_c are assumed exogenous and identical for all households. The per-hour child care service fee is a fixed fraction κ of the market wage w , and informal care is excluded.

The number and age of children in a household are fully determined by the household’s age j and education θ . All parents have two children, $\bar{n}c = 2$, over their lifetime. Child spacing is uniform, although the timing of births varies by education: low-education households (θ_L) have earlier births than high-education households (θ_H). The k^{th} child is born in parent household age $j = b_{k,\theta}$ and remains dependent until age 18 (i.e., from $j = b_{k,\theta}$ to $j = b_{k,\theta} + 17$). Afterwards, the child leaves home permanently, ending the parent-child link. The number of children in a household of age j and education θ is therefore calculated as $nc_{j,\theta} = \sum_{k=1}^{\bar{n}c} \mathbf{1}_{\{b_{k,\theta} \leq j \leq b_{k,\theta} + 17\}}$.

²⁵New features introduced in this paper include: (i) a more detailed representation of family composition (by incorporating childless couples); (ii) fully endogenized female labor supply decisions at both the intensive and extensive margins (Subsections 4.3 and 4.7); and (iii) a decomposition of welfare measures to identify key drivers of welfare changes (Subsection 4.10). Furthermore, while [Tin and Tran \(2024\)](#) focus on child benefit reforms to improve aggregate and distributional outcomes, this paper extends their analysis by exploring a joint design of taxes and child benefits that maximizes overall ex-ante welfare.

²⁶Population growth (g_N) and conditional survival probabilities (ψ) approximate the population structure and serve as weighting factors in the aggregation of cohort-based variables.

²⁷Children indirectly affect household utility through time costs (impacting leisure) and child care expenses (affecting budget constraints). I also assume that children and population growth are detached, and resources allocated to a child’s upbringing do not contribute to future labor productivity. Additionally, because fertility is exogenous, modeling children as director contributors to household utility is unnecessary beyond their indirect effects.

4.2 Preferences

Household preferences are represented by a time-separable expected utility function

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

where β is the time discount factor, c is joint consumption, $l^m = 1 - n^m$ is male leisure, $l^f = 1 - n$ is female leisure, θ is education level, and λ is family type. Male labor supply (n^m) is exogenous, while female labor supply (n) is endogenous. $W(c_j, l_j^f)$ is the total expected utility expressed as a function of the decision variables.

Suppressing the age subscript j to ease notation, the periodic household utility functions for different family types—married parents, married childless couples, single childless men, and single mothers—are as follows:

$$\begin{aligned} u(c, l^m, l^f, \theta, \lambda = 1) &= \frac{\left[\left(\frac{c}{\iota_{1,\theta}} \right)^\nu (l^m)^{1-\nu} \right]^{1-\frac{1}{\gamma}} + \left[\left(\frac{c}{\iota_{1,\theta}} \right)^\nu (l^f)^{1-\nu} \right]^{1-\frac{1}{\gamma}}}{1 - \frac{1}{\gamma}} \\ u(c, l^m, l^f, \theta, \lambda = 2) &= \frac{\left[\left(\frac{c}{\iota_{2,\theta}} \right)^\nu (l^m)^{1-\nu} \right]^{1-\frac{1}{\gamma}} + \left[\left(\frac{c}{\iota_{2,\theta}} \right)^\nu (l^f)^{1-\nu} \right]^{1-\frac{1}{\gamma}}}{1 - \frac{1}{\gamma}} \\ u(c, l^m, \theta, \lambda = 3) &= \frac{[(c)^\nu (l^m)^{1-\nu}]^{1-\frac{1}{\gamma}}}{1 - \frac{1}{\gamma}} \\ u(c, l^f, \theta, \lambda = 4) &= \frac{\left[\left(\frac{c}{\iota_{4,\theta}} \right)^\nu (l^f)^{1-\nu} \right]^{1-\frac{1}{\gamma}}}{1 - \frac{1}{\gamma}} \end{aligned}$$

where ν is the taste for consumption, γ is the elasticity of intertemporal substitution (EIS) and $\iota_{\lambda,\theta} = \sqrt{\mathbf{1}_{\{\lambda \neq 3\}} + \mathbf{1}_{\{\lambda \neq 4\}} + nc_\theta}$ is the consumption equivalence scale. While the model does not explicitly include children in the utility functions, parents' concern for their children is partially reflected in their efforts to maximize per capita consumption in their household.

Consumption equivalence scale. Children increase household size and thus reduce per capita consumption. I capture this effect using the square root consumption equivalence scale $\iota_{\lambda,\theta}$, formally defined as:

$$\iota_{\lambda,\theta} = \sqrt{\mathbf{1}_{\{\lambda \neq 3\}} + \mathbf{1}_{\{\lambda \neq 4\}} + nc_\theta}$$

where $\mathbf{1}_{\{x\}}$ is an indicator function with a logical argument x , and $\mathbf{1}_{\{\lambda \neq 3\}} + \mathbf{1}_{\{\lambda \neq 4\}} + nc_\theta$ represents household size (number of adults and children).

$\iota_{\lambda,\theta}$ reflects economies of scale within households, as shared consumption (e.g., utilities and durable goods) means living costs do not increase linearly with each additional member. It also adjusts for household composition. For instance, a family of four (two parents and two children) requires more resources than a childless couple but not necessarily double.²⁸

4.3 Endowments

Married and single men. Male labor supply is exogenous. Men work full-time until retirement, earning labor income $y_{j,\lambda,\theta}^m = w n_{j,\lambda}^m e_{j,\lambda,\theta}^m$, where w is the market wage, $n_{j,\lambda}^m$ represents exogenous work hours, and $e_{j,\lambda,\theta}^m$ denotes earning ability. Their work hours, $n_{j,\lambda}^m = 1 - l_{j,\lambda}^m$, are normalized to average work hours over the

²⁸The consumption equivalence scale can also be interpreted as the required income to equalize per capita consumption levels between parent and non-parent households. For example, using the square root scale $\iota_{\lambda,\theta}$ to compare childless couples with parents of nc_θ children, a dollar to the former is equivalent to x dollars to the latter if $\frac{1}{\sqrt{2}} = \frac{x}{\sqrt{2 + nc_\theta}}$. This results in equivalencies of \$1.22 for couples with one child and \$1.41 for those with two children. While the square root scale is adopted for ease of computation, these implied equivalent incomes closely align with average estimates for Australia in the [Department of Social Services \(DSS\) report](#) and for New Zealand by [Chatterjee and Michelini \(1998\)](#).

working age. Earning ability is composed of deterministic (\bar{e}_j) and stochastic (ϵ_j^m) components:

$$e_{j,\lambda,\theta}^m = h_{j,\lambda,\theta}^m \times \epsilon_j^m$$

where $h_{j,\lambda,\theta}^m$ is a concave function of age j , conditional on education θ and family type λ . The stochastic component ϵ_j^m follows a first-order autoregressive process

$$\overbrace{\ln(\epsilon_j^m)}^{=\eta_j^m} = \rho \times \overbrace{\ln(\epsilon_{j-1}^m)}^{=\eta_{j-1}^m} + v_j^m \quad (31)$$

with persistence parameter ρ and a white-noise disturbance $v_j^m \sim N(0, \sigma_v^2)$.

Married and single women. Female labor supply is endogenous. A household chooses work hours n for its female member, which then determines her employment status: staying at home ($\ell = 0$ if $n = 0$), working part-time ($\ell = 1$ if $n \in (0, n_1)$), or working full-time ($\ell = 2$ if $n \in [n_1, 1)$).

The female labor supply decision process is detailed in Subsection 4.7. In brief, it involves balancing work-related trade-offs—such as earnings, child care costs, and human capital accumulation—to maximize household lifetime utility. These trade-offs shape female labor supply behavior, their responsiveness to transfer schemes, and consequently, their reactions to policy reforms in counterfactual economies.

1. **Benefits of working:** If a woman works, she: (i) *earns labor income*, $y_j^f = w n_j e_{j,\theta,\ell}^f$; (ii) *accumulates human capital for the next period*, $h_{j+1,\theta,\ell}^f$; and (iii) *receives a subsidy sr_j per dollar spent on child care*, provided she meets the CCS criteria outlined in Section 5.5. Her earning ability is given by:

$$e_{j,\theta,\ell}^f = h_{j,\theta,\ell}^f \times \epsilon_j^f$$

where the deterministic part $h_{j,\theta,\ell}^f$ is her human capital, which depends on her education θ and current employment status ℓ . Unlike men, however, female human capital $h_{j,\theta,\ell}^f$ evolves endogenously over her life cycle according to the law of motion (47). In short, working today ($\ell > 0$) not only generates immediate income but also enhances future earning ability, while staying at home ($\ell = 0$) leads to depreciation of this ability. The stochastic component ϵ_j^f evolves as:

$$\overbrace{\ln(\epsilon_j^f)}^{=\eta_j^f} = \rho \times \overbrace{\ln(\epsilon_{j-1}^f)}^{=\eta_{j-1}^f} + v_j^f \quad (32)$$

where ρ is the persistence parameter, and $v_j^f \sim N(0, \sigma_v^2)$ is a white-noise disturbance with innovation term σ_v^2 , identical to the stochastic process for male earnings.

2. **Costs of working:** Labor force participation incurs costs, including: (i) *formal child care costs per child*, κ_j ; (ii) *potential reduction or loss of means-tested child benefits*, and (iii) *employment-specific (ℓ -specific) fixed time costs*, $\chi_{\lambda,\ell}$, which reduce leisure. I also assume spouses are perfectly altruistic, sharing fixed time costs evenly in married households ($\lambda \in \{1, 2\}$). Specifically, at age j , a woman's leisure time l_j^f depends on her employment status as follows:

$$l_j^f = \begin{cases} 1 & \text{if staying at home } (\ell = 0) \\ 0 < 1 - n_j - \chi_{j,\lambda,1} < 1 & \text{if single } (\lambda = 4) \text{ and working part-time } (\ell = 1) \\ 0 < 1 - n_j - \frac{\chi_{j,\lambda,1}}{2} < 1 & \text{if married } (\lambda \in \{1, 2\}) \text{ and working part-time } (\ell = 1) \\ 0 < 1 - n_j - \chi_{j,\lambda,2} < 1 & \text{if single } (\lambda = 4) \text{ and working full-time } (\ell = 2) \\ 0 < 1 - n_j - \frac{\chi_{j,\lambda,2}}{2} < 1 & \text{if married } (\lambda \in \{1, 2\}) \text{ and working full-time } (\ell = 2) \end{cases} \quad (33)$$

where the fixed costs, $\chi_{\lambda,\ell}$, vary between parents ($\lambda \in \{1, 4\}$) and non-parents ($\lambda = 2$), and depend on employment status (ℓ). They decrease monotonically with age and follow a parametric form:

$$\chi_{\lambda,\ell}(j) = \frac{\chi_{\lambda,\ell}^y}{1 + e^{\chi_{\lambda,\ell}^s(j - \bar{j}_\lambda)}} \quad (34)$$

where $\chi_{\lambda,\ell}^y = \chi_{\lambda,\ell}^{max} \times (1 + e^{\chi_{\lambda,\ell}^s(1 - \bar{j}_\lambda)})$ governs the maximum fixed cost $\chi_{\lambda,\ell}^{max} = \chi_{\lambda,\ell}(1)$ at age $j = 1$ (i.e., the intercept of the fixed-cost profile). \bar{j}_λ is the inflection point, and $\chi_{\lambda,\ell}^s$ controls the slope, determining how quickly fixed costs decline with age. A higher $\chi_{\lambda,\ell}^s$ results in an inverse sigmoid profile, where fixed costs remain close to their maximum value for younger women and decline sharply around \bar{j}_λ .

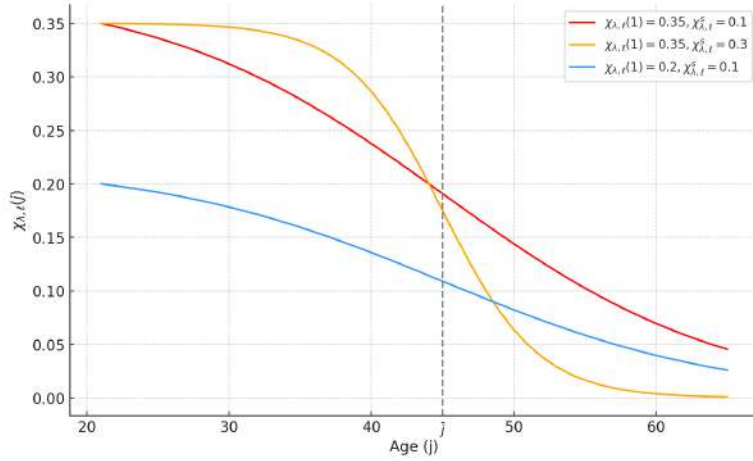


Figure 7: **Fixed cost function.**

Notes: The figure shows the age profiles of fixed cost to leisure for women for three different parameterizations.

The female labor supply decision therefore balances the benefits (e.g., earnings, human capital accumulation, and child care subsidies) against the costs (e.g., child care expenses, reduced child benefits, and fixed time costs). These dynamics shape labor supply behavior, especially in response to policy reforms, as explored in Section 6.

4.4 Technology

In every time period t , a representative firm uses labor-augmenting technology A_t and a Cobb-Douglas production function $Y_t = K_t^\alpha (A_t L_t)^{1-\alpha}$ to transform capital K_t and total labor services L_t into output Y_t . The technology A_t grows at a constant rate g_A .

In this small open economy model, the free flow of foreign capital $B_{F,t}$ ensures that the domestic real interest rate r is equal to the constant world interest rate r_w under a no-arbitrage condition. As a result, the domestic real interest rate r and thus the wage rate w remain unchanged across steady states.

The firm pays a capital income tax τ_t^k and chooses its capital and labor inputs to maximize profit, taking the capital rental rate $q = r + \delta$, where δ denotes the depreciation rate of capital, and the wage rate w as given.

The firm's problem is:

$$\max_{K_t, L_t} (1 - \tau_t^k)(Y_t - w A_t L_t) - q K_t \quad (35)$$

The firm's first-order conditions for profit maximization are:

$$r = (1 - \tau_t^k) \alpha \frac{Y_t}{K_t} - \delta \quad (36)$$

$$w = (1 - \alpha) \frac{Y_t}{A_t L_t} \quad (37)$$

4.5 Fiscal policy

I model key features of the Australian fiscal system, including a progressive income tax system, two means-tested child benefit programs for families with children, and a means-tested Age Pension program for retirees.

4.5.1 Tax system

Progressive income tax. The government levies taxes on individual labor earnings.²⁹ I model a progressive tax scheme to capture the interactions between taxes and child benefits across income levels. For example, in low-income brackets with low or no tax liabilities, the the phase-out rate of the FTB might have limited work disincentive effects compared to its effects under a proportional tax scheme. Conversely, in high-income brackets, the distortions could be more pronounced.

I approximate the tax schedule using a parametric tax function following [Feldstein \(1969\)](#); [Benabou \(2000\)](#), and [Heathcote et al. \(2017\)](#). The individual income tax is expressed as:

$$tax_j^i = \max \left\{ 0, \tilde{y}_j^i - \zeta (\tilde{y}_j^i)^{1-\tau} \right\} \quad (38)$$

Here, tax_j^i denotes the tax payment for an individual $i \in \{m, f\}$ at age j , \tilde{y}_j^i is the taxable income (equals labor earnings), ζ is a scaling parameter, and τ is a progressivity parameter.

τ controls the progressivity of the tax system. At one extreme, as τ approaches infinity, tax_j^i approaches \tilde{y}_j^i , implying 100% taxation of taxable income. At the other extreme, when $\tau = 0$, then $tax_j^i = (1 - \zeta) \tilde{y}_j^i$, making $(1 - \zeta)$ a flat tax rate. As τ increases (or *decreases*), the marginal tax rate (MTR) and average tax rate (ATR) increase (or *decrease*) for a given income level. A non-negative tax restriction is applied to exclude government transfers in the form of negative income taxes.

ζ serves as the public budget-balancing variable. Adjusting ζ shifts the overall tax schedule without altering its progressivity. A higher ζ shifts the tax schedule downward, reducing the tax burden across all income levels and expanding the zero-tax income bracket. Conversely, a lower ζ increases the overall tax burden and compresses the zero-tax income bracket. Figure 8 illustrates these effects.

4.5.2 Transfer system

The government operates a means-tested child benefit system to support families with dependent children through two main programs: the Family Tax Benefit (Part A and Part B) and the Child Care Subsidy. Below is a simplified overview of these programs. For detailed information, refer to Appendix Section [H.2](#).

Family Tax Benefit Part A (FTB-A). The FTB-A is paid per dependent child. The claimable amount depends on the household's combined taxable income, as well as the age and number of dependent children. Key policy parameters determining the levels, kinks, and slopes of the FTB-A schedule are: (i) maximum and base payments per child, tr_j^{A1} and tr_j^{A2} ; (ii) joint income test thresholds for maximum and base payments, \bar{y}_{max}^{tr} and \bar{y}_{base}^{tr} ; and (iii) phase-out rates for maximum and base payments, ω_{A1} and ω_{A2} . Accordingly, the

²⁹ Australia operates a separate tax filing system that treats individuals, not households, as the basic unit for income tax purposes. This model excludes capital earnings taxes and franking credits under Australia's dividend imputation system. Franking credits ensure that corporate taxes paid by firms are credited to households (shareholders), preventing double taxation. I assume that the representative firm pays corporate taxes (τ^k) and distributes fully franked dividends to households, exempting them from capital earnings tax. For further details, see [the Parliamentary Budget Office \(PBO\) 2024 report](#) on dividend imputation and franking credits.

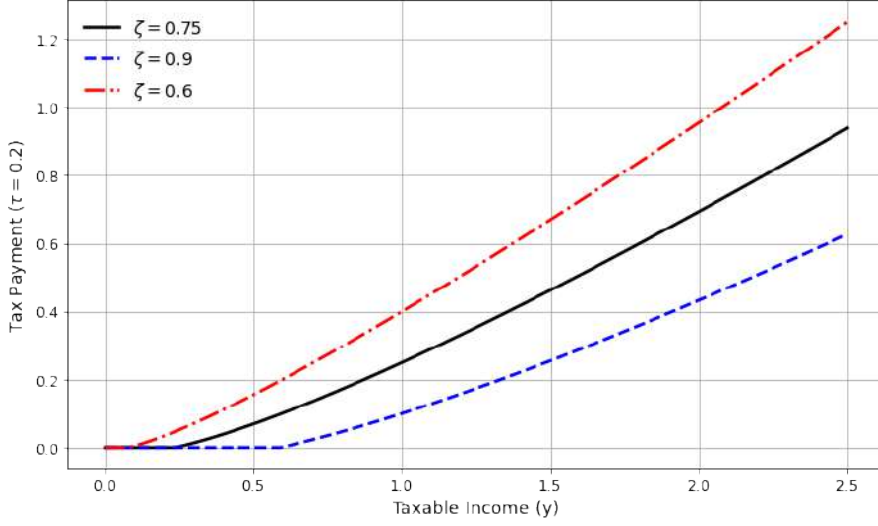


Figure 8: Tax schedules for $\tau = 0.2$ and different parametrization of ζ .

FTB-A benefit per child, tr_j^A , is given by:

$$tr_j^A = \begin{cases} tr_j^{A1} & \text{if } y_{j,\lambda} \leq \bar{y}_{max}^{tr} \\ \max \{ tr_j^{A2}, tr_j^{A1} - \omega_{A1} (y_{j,\lambda} - \bar{y}_{max}^{tr}) \} & \text{if } \bar{y}_{max}^{tr} < y_{j,\lambda} \leq \bar{y}_{base}^{tr} \\ \max \{ 0, tr_j^{A2} - \omega_{A2} (y_{j,\lambda} - \bar{y}_{base}^{tr}) \} & \text{if } y_{j,\lambda} > \bar{y}_{base}^{tr}, \end{cases} \quad (39)$$

where $y_{j,\lambda} = \mathbf{1}_{\{\lambda \neq 4\}} y_{j,\lambda}^m + \mathbf{1}_{\{\lambda \neq 3, \ell \neq 0\}} y_j^f + ra_j$ denotes household's combined income.

Family Tax Benefit Part B (FTB-B). The FTB-B is paid per household as additional support for single parents and single-earner partnered parents with limited means. Similar to the FTB-A, it is a function of the age and number of dependent children. However, eligibility and payment amounts depend on marital status and separate income tests for primary and secondary earners. Key policy parameters determining the levels, kinks, and slopes of the FTB-B schedule are: (i) two maximum payments for families with children aged below 5 or between 5 and 18, tr_j^{B1} and tr_j^{B2} ; (ii) income test thresholds for primary and secondary earners, \bar{y}_{pe}^{tr} and \bar{y}_{se}^{tr} ; and (iii) a phase-out rate based on the secondary earner's taxable income, ω_B . Let $y_{pe} = \max(y_{j,\lambda}^m, y_j^f)$ and $y_{se} = \min(y_{j,\lambda}^m, y_j^f)$ denote the primary and secondary earners' taxable incomes, respectively. The FTB-B benefit per household, tr_j^B , is:

$$tr_j^B = \begin{cases} \Upsilon_1 \times tr_j^{B1} + \Upsilon_2 \times tr_j^{B2} & \text{if } y_{pe} \leq \bar{y}_{pe}^{tr} \text{ and } y_{se} \leq \bar{y}_{se}^{tr} \\ \Upsilon_1 \times \max \{ 0, tr_j^{B1} - \omega_B (y_{se} - \bar{y}_{se}^{tr}) \} & \text{if } y_{pe} \leq \bar{y}_{pe}^{tr} \text{ and } y_{se} > \bar{y}_{se}^{tr} \\ + \Upsilon_2 \times \max \{ 0, tr_j^{B2} - \omega_B (y_{se} - \bar{y}_{se}^{tr}) \} & \end{cases} \quad (40)$$

where $\Upsilon_1 = \mathbf{1}_{\{nc_{[0,4],j} \geq 1\}}$ and $\Upsilon_2 = \mathbf{1}_{\{nc_{[0,4],j} = 0 \text{ and } nc_{[5,18],j} \geq 1\}}$ are indicator variables representing whether a household aged j has dependent children in the specified age ranges $[a, b]$, and nc denotes the number of children.

Child care subsidy (CCS). The CCS subsidizes formal child care costs for children aged 13 or younger. Like the FTB, the CCS is means-tested based on family income and depends on the age and number of children. However, unlike the FTB, the CCS is also conditional on work.³⁰ Key parameters determining eligibility and subsidy rate per child include: (i) joint income test thresholds, $\{\bar{y}_1^{sr}, \bar{y}_2^{sr}, \bar{y}_3^{sr}, \bar{y}_4^{sr}, \bar{y}_5^{sr}\}$; (ii) fortnightly work hour test thresholds, $\{0, 8, 16, 48\}$; and (iii) phase-out rates, $\{\omega_c^1, \omega_c^3\}$. The base CCS rate per child, denoted

³⁰In practice, the CCS assesses the number of hours spent on recognized activities, which comprise paid work (self-employment included), unpaid work in a family business, volunteering, and job-seeking activities, among others.

by sr , for a household aged j is given by:

$$sr = \Psi(y_{j,\lambda}, n_{j,\lambda}^m, n_j) \times \begin{cases} sr_1 & \text{if } y_{j,\lambda} \leq \bar{y}_1^{sr} \\ \max\{sr_2, sr_1 - \omega_c^1\} & \text{if } \bar{y}_1^{sr} < y_{j,\lambda} < \bar{y}_2^{sr} \\ sr_2 & \text{if } \bar{y}_2^{sr} \leq y_{j,\lambda} < \bar{y}_3^{sr} \\ \max\{sr_3, sr_2 - \omega_c^3\} & \text{if } \bar{y}_3^{sr} \leq y_{j,\lambda} < \bar{y}_4^{sr} \\ sr_3 & \text{if } \bar{y}_4^{sr} \leq y_{j,\lambda} < \bar{y}_5^{sr} \\ sr_4 & \text{if } y_{j,\lambda} \geq \bar{y}_5^{sr}, \end{cases} \quad (41)$$

where $y_{j,\lambda} = \mathbf{1}_{\{\lambda \neq 4\}} y_{j,\lambda}^m + \mathbf{1}_{\{\lambda \neq 3, \ell \neq 0\}} y_j^f + ra_j$ is the joint family income, and ω_c^i is the phase-out rate. $\Psi(y_{j,\lambda}, n_{j,\lambda}^m, n_j)$ is the adjustment factor applied to the base subsidy rate based on the lower of the two spouses' work hours if married, or the individual's work hours if single. Let $n_j^{min} = \min\{n_{j,\lambda}^m, n_j\}$ be the household's minimum work hours. The adjustment factor is:

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

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

Age pension. The Age pension is a means-tested benefit for retirees, based on both income and assets tests, and is independent of contribution history. The pension becomes accessible to households once they reach the qualifying age, $j = J_R$. The pension benefit based on the assets test, denoted as $\mathcal{P}^a(a_j)$, is determined as follows:

$$\mathcal{P}^a(a_j) = \begin{cases} p^{\max} & \text{if } a_j \leq \bar{a}_1^P \\ \max\{0, p^{\max} - \omega_a(a_j - \bar{a}_1^P)\} & \text{if } a_j > \bar{a}_1^P \end{cases} \quad (42)$$

where p^{\max} is the maximum pension payment, \bar{a}_1^P is the assets test threshold, and ω_a is the phase-out rate for the assets test.

Similarly, the pension benefit according to the income test, denoted as $\mathcal{P}^y(y_{j,\lambda})$, is given by:

$$\mathcal{P}^y(y_{j,\lambda}) = \begin{cases} p^{\max} & \text{if } y_{j,\lambda} \leq \bar{y}_1^P \\ \max\{0, p^{\max} - \omega_y(y_{j,\lambda} - \bar{y}_1^P)\} & \text{if } y_{j,\lambda} > \bar{y}_1^P \end{cases} \quad (43)$$

where \bar{y}_1^P is the income test threshold, and ω_y is the phase-out rate for the income test.

Given $\mathcal{P}^a(a_j)$ and $\mathcal{P}^y(y_{j,\lambda})$, the pension benefit, pen_j , received by a household is:

$$pen_j = \begin{cases} \min\{\mathcal{P}^a(a_j), \mathcal{P}^y(y_{j,\lambda})\} & \text{if } j \geq J_P \text{ and } \lambda = 1, 2 \\ \frac{2}{3} \min\{\mathcal{P}^a(a_j), \mathcal{P}^y(y_{j,\lambda})\} & \text{if } j \geq J_P \text{ and } \lambda = 2, 3 \\ 0 & \text{otherwise} \end{cases} \quad (44)$$

Government budget. At time t , the government collects taxes on consumption, corporate profits, 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) general government purchases (G_t), (ii) child benefits ($Tr_t = FTB_t + CCS_t$), and (iii) the Age Pension (\mathcal{P}_t). The inter-temporal government budget constraint is:

$$T_t^C + T_t^K + T_t^I + (B_{t+1} - B_t) = G_t + Tr_t + \mathcal{P}_t + r_t B_t \quad (45)$$

4.6 Market structure

Markets are incomplete. Households cannot hedge against idiosyncratic earnings and mortality risks by trading state-contingent assets. They can only hold one-period risk-free assets to insure against these risks, subject to a no-borrowing constrain that ensures asset holdings are always non-negative.

The model economy is a small open economy where the free flow of foreign capital guarantees that the domestic interest rate is maintained at the constant world interest rate r^w . Additionally, the model abstracts

from labor market frictions, assuming no search or matching processes for employment and no adjustment costs when transitioning between part-time and full-time work.

4.7 The household problem

Households are heterogeneous along multiple dimensions:

- Age: $j \in \{1, 2, \dots, J\}$,
- Family type: $\lambda \in \Lambda$, where $\Lambda = \{1, 2, 3, 4\}$,
- Asset holdings: $a_j \in A$, where $A = [a_{min}, a_{max}] \subset \mathcal{R}^+$,
- Female human capital: $h_{j,\theta,\ell}^f \in H$, where $H = [h_{min}, h_{max}] \subset \mathcal{R}^+$,
- Education (permanent, realized at birth): $\theta \in \Theta$, where $\Theta = \{\theta_L, \theta_H\}$,
- Transitory shocks to male and female labor income: ϵ_j^m and $\epsilon_j^f \in S$, where $S \subset \mathcal{R}$.

Define $Z = \Lambda \times A \times H \times \Theta \times S \times S$ as the state space for households aged j . Let $z = \{\lambda_j, a_j, h_{j,\theta,\ell}^f, \theta, \eta_j^m, \eta_j^f\} \in Z$ denote the current-period state vector, and $z_+ = \{\lambda_{j+1}, a_{j+1}, h_{j+1,\theta,\ell}^f, \theta, \eta_{j+1}^m, \eta_{j+1}^f\} \in Z$ be the next-period state vector. To simplify the description below, age and time subscripts (j and t) are omitted where appropriate.

4.7.1 Working-age households

The decision process of working-age households varies by family type λ . Married households ($\lambda \in \{1, 2\}$) and single-mother households ($\lambda = 4$) must decide on female labor supply, whereas single male households ($\lambda = 3$) do not. The decision-making processes are as follows:

Working-age married and single-mother households ($\lambda \in \{1, 2, 4\}$). For every working age $j < J_R$, married households and single-mother households decide on joint consumption, savings, and labor supply for the female member. Given the behavioral, technological, and policy parameters, and a state vector z realized at the beginning of working age $j < J_R$, they go through the following decision-making procedure:

1. **Female work hours** (n): Every household chooses work hours n for its female member, which determines her employment status and next-period human capital as follows:

- (a) Female employment status (ℓ):

$$\ell = \begin{cases} 0 \text{ (staying at home)} & \text{if } n = 0 \\ 1 \text{ (working part-time)} & \text{if } n = (0, \bar{n}_1) \\ 2 \text{ (working full-time)} & \text{if } n = [\bar{n}_1, 1) \end{cases} \quad (46)$$

where \bar{n}_1 is the normalized work hour floor for full-time employment. I assume strictly positive female leisure ($l^f > 0$), implying that her maximum full-time work hours are less than 1.

- (b) Next-period human capital ($h_{j+1,\theta,\ell}^f$):

$$\log(h_{j+1,\theta,\ell}^f) = \log(h_{j,\theta,\ell}^f) + (\xi_{1,\theta,\ell} - \xi_{2,\theta,\ell} \times j) \mathbf{1}_{\{\ell > 0\}} - \delta_h(1 - \mathbf{1}_{\{\ell > 0\}}) \quad (47)$$

where the law of motion (47) governs the evolution of female human capital, δ_h is the depreciation rate of human capital when not working, and $\mathbf{1}_{\{x\}}$ is an indicator function with a logical argument x . A working woman ($\ell > 0$) accumulates human capital at a diminishing rate over age. Her human

capital gain rate is governed by the coefficient $\xi_{1,\theta,\ell} - \xi_{2,\theta,\ell} \times j$, a composite of two parameters $\xi_{1,\theta,\ell}$ and $\xi_{2,\theta,\ell}$ that depend on education and employment status.³¹

2. **ℓ -specific next-period assets (a_+) and labor supply (n):** For each employment status $\ell \in \{0, 1, 2\}$, the household chooses ℓ -specific joint consumption $c(\ell, z)$, next-period asset holdings $a_+(\ell, z)$, and female work hours $n(\ell, z)$ from a choice set $\mathcal{C} \equiv \{(c, n, a_+) \in \mathcal{R}^{++} \times [0, 1] \times \mathcal{R}^+\}$ to maximize its expected lifetime utility. Specifically, the household determines the ℓ -specific optimal allocations of next-period assets $a_+(\ell, z)$ and female work hours $n(\ell, z)$ by solving (numerically) its value function problem (48) and intra-temporal trade-off equation (50):

(a)

$$V(z, \ell) = \max_{a_+, n} \left\{ u(c, l^m, l^f, \theta, \lambda) + \beta \sum_{\Lambda} \int_{S^2} V(z_+) d\Pi(\lambda_+, \eta_+^m, \eta_+^f \mid \lambda, \eta^m, \eta^f) \right\} \quad (48)$$

s.t.

$$\begin{aligned} \underbrace{(1 + \tau^c)c + \mathbf{1}_{\{\lambda=1,4\}}n \times CE_\theta(n, a)}_{\text{Expense}} + \underbrace{(a_+ - a)}_{\text{Savings}} &= \underbrace{y_\lambda(n, a) + \mathbf{1}_{\{\lambda=1,4\}}FTB_\theta(n, a) + beq - T_\lambda(n)}_{\text{Disposable income}} \\ l^f &= 1 - n - \underbrace{\mathbf{1}_{\{\lambda=1,2\}}\frac{\chi_{\lambda,\ell}}{2} - \mathbf{1}_{\{\lambda=4\}}\chi_{\lambda,\ell}}_{\text{Fixed time cost}} \\ l^m &= 1 - n_\lambda^m - \frac{\chi_{\lambda,\ell}}{2} \quad \text{if } \lambda \in \{1, 2\} \\ c &> 0 \\ a_+ &\geq 0 \end{aligned} \quad (49)$$

Here, $y_\lambda(n, a) = \mathbf{1}_{\{\lambda \neq 4\}}y_\lambda^m + \mathbf{1}_{\{\ell \neq 0\}}y^f(n) + ra$ is the household market income; $CE_\theta(n, a) = w(1 - sr(n, a)) \sum_{i=1}^{nc_\theta} \kappa_i$ represents the net formal child care costs per work hour, where sr is the CCS rate and κ_i is the hourly child care cost for the i^{th} child as a fraction of wages; $FTB_\theta(n, a) = nc_\theta \times tr^A(n, a) + tr^B(n, a)$ is the total FTB transfer, with tr^A and tr^B calculated using (39) and (40), respectively; τ^c denotes the consumption tax; and $T_\lambda(n) = \mathbf{1}_{\{\lambda \neq 4\}}tax^m + tax^f(n)$ is the total income tax payment, with tax^i for $i \in \{m, f\}$ determined by (38). Leisure is strictly positive, such that $l^i \in (0, 1]$. Bequest motives are not operative. Households are born with no wealth ($a_1 = 0$) and receive a uniform lump-sum accidental bequest (beq) from deceased households in the same period.

- (b) For each $a_+(\ell, z)$, the household solves for the corresponding female work hours $n(\ell, z) = n(a_+|\ell, z)$ that satisfy the following intra-temporal trade-off equation:

$$n(a_+|\ell, z) = \frac{a_+(\ell, z) + \frac{\nu}{1-\nu} (1 - EMTR_{y^f, \lambda}(n, a)) we_{\theta, \ell}^f - (NLI_\lambda(n, a) - T_\lambda(n))}{we_{\theta, \ell}^f \left[1 + \frac{\nu}{1-\nu} (1 - EMTR_{y^f, \lambda}(n, a)) \right] - \mathbf{1}_{\{\lambda=1,4\}}CE_\theta(n, a)} \quad (50)$$

On the right-hand side (RHS), $EMTR_{y^f, \lambda}(n, a)$ represents the effective marginal tax rate (EMTR) with respect to female labor earnings y^f , and $NLI_\lambda(n, a)$ is the total non-labor income. These terms are defined as follows:

³¹Human capital gains reflect experience, skill acquisition, and other improvements derived from work, which translate into higher future labor returns. Thus, the law of motion employed is based on a learning-by-doing framework rather than on-the-job training. The latter approach would require the agent to actively invest in human capital by splitting her work hours between productive and training times. A part of the complication of this setup arises from the difficulty in identifying the returns to productive time in empirical data due to the lack of direct observation.

$$\begin{aligned}
EMTR_{yf,\lambda}(n,a) &= \underbrace{\frac{\partial T_\lambda}{\partial y^f}(n)}_{MTR} + \mathbf{1}_{\{\lambda=1,4\}} \left(\underbrace{\frac{CE_\theta(n,a)}{we_{\theta,\ell}^f}}_{\text{Net child care costs}} + \underbrace{\left(wn \times \frac{\partial sr}{\partial y^f}(n,a) - \frac{n}{e_{\theta,\ell}^f} \times \frac{\partial sr}{\partial n}(n,a) \right)}_{CCS} \sum_{i=1}^{nc_\theta} \kappa_i \right) \\
&\quad + \mathbf{1}_{\{\lambda=1,4\}} \left(\underbrace{nc_\theta \times \frac{\partial tr^A}{\partial y^f}(n,a)}_{FTB-A} + \underbrace{\frac{\partial tr^B}{\partial y^f}(n,a)}_{FTB-B} \right) \quad (51)
\end{aligned}$$

$$NLI_\lambda(n,a) = (1+r)a + \mathbf{1}_{\{\lambda=1,4\}} (nc_\theta \times tr^A(n,a) + tr^B(n,a)) \quad (52)$$

Equation (50) shows that the income tax T_λ affects labor supply through two primary channels: (i) a negative income effect (IE) as it reduces non-labor income NLI_λ , encouraging more labor hours, and (ii) a marginal tax rate (MTR) $\frac{\partial T_\lambda}{\partial y^f}$ that distorts female labor supply decisions. Equation (51) also demonstrates that parents face additional distortions due to child care costs and phase-out rates of benefits, leading to higher $EMTR_{yf,\lambda}(n,a)$. First, hourly child care expenses make work inherently more costly for mothers. Second, the FTB and CCS phase-out rates function as implicit marginal taxes on labor income, counteracting the intended work incentive effects of the CCS subsidy (sr). These results align with the simulated EMTR schedules in Figures 5 and 6 (Section 2), which illustrate how FTB and CCS phase-out rates negate the the CCS program's intended work incentive effects. Detailed derivations of Equation (50) are provided in Subsection E.1 of the Appendix.

3. **Optimal choice** (c^*, n^*, a_+^*): Each ℓ -specific optimal value $V(\ell, z)$ corresponds to an optimal pair $a_+^*(\ell, z)$ and $n^*(\ell, z)$. The household selects the employment status ℓ^* for its female member that maximizes the utility:

$$\ell^* = \operatorname{argmax} \{V(0, z), V(1, z), V(2, z)\}$$

The maximal attainable utility is therefore $V^*(z) = V(\ell^*, z)$. The associated optimal next-period assets and female work hours are $a_+^* = a_+^*(\ell^*, z)$ and $n^* = n^*(\ell^*, z)$, respectively.³² Given a_+^* and n^* , the optimal consumption c^* is obtained via the household budget constraint (49).

Working-age single male households ($\lambda = 3$). Single male households do not make labor supply decisions, as their labor supply profile is exogenously determined over the life cycle. For every age $j < J_R$, they choose an optimal pair $\{a_+^*(z), c^*(z)\}$ to maximize their expected lifetime utility. The problem thus simplifies to a consumption-savings optimization problem, subject to the budget constraint (54):

$$V(z) = \max_{a_+} \left\{ u(c, \theta) + \beta \sum_{\Lambda} \int_{S^2} V(z_+) d\Pi(\lambda_+, \eta_+^m \mid \lambda, \eta^m) \right\} \quad (53)$$

s.t.

$$\begin{aligned}
(1 + \tau^c)c + (a_+ - a) &= y_\lambda(a) + beq - T_\lambda \\
l^m &= 1 - n_\lambda^m \\
c &> 0 \\
a_+ &\geq 0
\end{aligned} \quad (54)$$

where $y_\lambda(a) = y_\lambda^m + ra$, and $T_\lambda = tax^m$ based on the tax function (38).

³²To break ties where $V(\ell_a, z) = V(\ell_b, z)$ and $\ell_a \neq \ell_b$, I assume the household chooses the employment status ℓ_a that requires fewer work hours, $n(\ell_a) < n(\ell_b)$, reflecting the preference for leisure over work.

4.7.2 Retirees

Retirement is mandatory and begins at age J_R , at which point education and transitory shock states become absorptive. Retirees do not have dependent children, and are therefore not eligible for child benefits. However, they may qualify for the Age Pension, which is means-tested based on income and asset holdings. Pension payments are not contingent on an individual's earnings history but vary by family type λ . Single households receives two-thirds of the pension payment available to a couple. The state vector of a retired household aged $J_R \leq j \leq J$ therefore reduces to $z^R = \{\lambda, a\} \in \{1, 2, 3, 4\} \times R_+$, and their choice set is $\mathcal{C}^R \equiv \{(c, a_+) \in \mathcal{R}^{++} \times \mathcal{R}^+\}$. The retired household's optimization problem simplifies to:

$$V(z^R) = \max_{a_+} \left\{ u(c, \lambda) + \beta \sum_{\Lambda} V(z_+^R) d\Pi(\lambda_+|\lambda) \right\} \quad (55)$$

$$\begin{aligned} (1 + \tau^c)c + (a_+ - a) &= ra + \text{pen}(a, \lambda) \\ c &> 0 \\ a_+ &\geq 0 \quad \text{and} \quad a_{J+1} = 0 \end{aligned} \quad (56)$$

where $\text{pen}(a, \lambda)$ is the Age Pension as described in Equation (44), and $a_{J+1} = 0$ enforces the assumption that retirees exhaust their assets by the end of life, reflecting a no-bequest motive.

4.8 Competitive equilibrium

The distribution of households. Let $\phi_t(z)$ denote the stationary density and $\Phi_t(z)$ the cumulative distribution of households aged j , at time t , unadjusted for population growth.³³ Given that all households enter the economy with identical female human capital set at unity ($h_{j=1}^f = 1$) and no assets ($a_{j=1} = 0$), the initial distribution of newborn households (aged $j = 1$) in every period t is determined by:

$$\begin{aligned} \sum_{\Lambda \times \Theta} \int_{A \times H \times S^2} d\Phi_t(\lambda_1, a_1, h_1^f, \theta, \eta_1^m, \eta_1^f) &= \sum_{\Lambda \times \Theta} \int_{S^2} d\Phi_t(\lambda_1, 0, 1, \theta, \eta_1^m, \eta_1^f) = 1, \quad \text{and} \\ \phi_t(\lambda_1, 0, 1, \theta, \eta_1^m, \eta_1^f) &= \prod_{x \in \{\lambda_1, \theta, \eta_1^m, \eta_1^f\}} \pi(x) \end{aligned}$$

where h_j^f is shorthand for $h_{j,\theta,\ell}^f$, and $\pi(x)$ is the unconditional probability density of a state vector $x \in \{\lambda_1, \theta, \eta_1^m, \eta_1^f\}$ for newborns, with $\lambda_1 \in \Lambda$, $\theta \in \Theta$, and $\eta_1^m, \eta_1^f \in S$.

From age $j = 2$ onward, the next-period population density $\phi_+(z_+)$ evolves according to the following law of motion:

$$\phi_+(z_+) = \sum_{\Lambda \times \Theta} \int_{A \times H \times S^2} \mathbf{1}_{\{a_+ = a_+(z, \Omega), h_+^f = h_+^f(z, \Omega)\}} \times \pi(\lambda_+|\lambda) \times \pi(\eta_+^m|\eta^m) \times \pi(\eta_+^f|\eta^f) d\Phi(z) \quad (57)$$

where age and time subscripts are omitted for brevity; Ω is a vector of behavioral, technology, and policy parameters at time t ; $\pi(\eta_+^i|\eta^i)$ is the conditional probability of η_+^i given η^i , obtained from discretizing the AR(1) stochastic earnings process ϵ^i , as shown in Equations (31) and (32), for $i \in \{m, f\}$; and $\pi(\lambda_+|\lambda)$ is the transition probability of λ_+ given λ from Table 1. Assets and human capital are endogenous states that evolve continuously. The share of households for each pair of $\{a_+, h_+^f\}$ is obtained through bilinear interpolation of a_+ and h_+^f on their respective discretized domains.

Aggregate variables. There are J generations living in every time period t . Let $\mu_{j,t}$ denote the share of households belonging to cohort j at time t , such that $\sum_{j=1}^J \mu_{j,t} = 1$. Taking into account the optimal allocations $\{c(z_j, \Omega_t), n(z_j, \Omega_t), a_+(z_j, \Omega_t)\}_{j=1}^J$ for a model economy governed by Ω_t in period t , the aggregate consumption C_t , wealth A_t , female labor force participation rate LFP_t , male work hours NM_t , female work

³³Since the population growth rate g_N is constant, it is factored in as a weighting factor when aggregating across cohorts. Mortality, which is age-dependent, is incorporated through the transition probabilities of family type λ , as described in Table 1. Thus, $\phi_t(z)$ also reflects the share of surviving households aged j at time t .

hours NF_t , and labor supply in efficiency units for males LM_t and females LF_t are expressed as below (with the subscript t suppressed for simplicity):³⁴

$$\begin{aligned}
C &= \sum_{j=1}^J \sum_{\Lambda \times \Theta} \int_{A \times H \times S^2} c(z_j, \Omega) \mu_j d\Phi(z_j) \\
A &= \sum_{j=1}^J \sum_{\Lambda \times \Theta} \int_{A \times H \times S^2} a(z_j, \Omega) \mu_j d\Phi(z_j) \\
LFP &= \sum_{j=1}^{J_R-1} \sum_{\Lambda \times \Theta} \int_{A \times H \times S^2} \mathbf{1}_{\{n(z_j, \Omega) > 0\}} \mu_j d\Phi(z_j) \\
NM &= \sum_{j=1}^{J_R-1} \sum_{\Lambda \times \Theta} \int_{A \times H \times S^2} n_{j,\lambda}^m \mu_j d\Phi(z_j) \\
NF &= \sum_{j=1}^{J_R-1} \sum_{\Lambda \times \Theta} \int_{A \times H \times S^2} n(z_j, \Omega) \mu_j d\Phi(z_j) \\
LM &= \sum_{j=1}^{J_R-1} \sum_{\Lambda \times \Theta} \int_{A \times H \times S^2} h_{j,\lambda}^m e^{\theta + \eta_j^m} n_{j,\lambda}^m \mu_j d\Phi(z_j) \\
LF &= \sum_{j=1}^{J_R-1} \sum_{\Lambda \times \Theta} \int_{A \times H \times S^2} h_{j,\theta,\ell}^f e^{\theta + \eta_j^f} n(z_j, \Omega) \mu_j d\Phi(z_j)
\end{aligned}$$

The aggregate government variables at time t are

$$\begin{aligned}
T^C &= \tau^c C \\
T^K &= \tau^k (Y - wAL) \\
T^I &= \sum_{j=1}^{J_R-1} \sum_{\Lambda \times \Theta} \int_{A \times H \times S^2} tax(z_j, \Omega) \mu_j d\Phi(z_j) \\
Tr &= \sum_{j=1}^{J_R-1} \sum_{\Lambda \times \Theta} \int_{A \times H \times S^2} (ftb(z_j, \Omega) + ccs(z_j, \Omega)) \mu_j d\Phi(z_j) \\
\mathcal{P} &= \sum_{j=J_R}^J \sum_{\Lambda} \int_A pen(z_j^R, \Omega) \mu_j d\Phi(z_j^R)
\end{aligned}$$

where, in every period t , $tax(z_j, \Omega)$ is calculated using Equation (38); $ftb(z_j, \Omega)$ is the Family Tax Benefit (FTB), calculated as $tr^A(z_j, \Omega) \times nc_{j,\theta} + tr^B(z_j, \Omega)$, where tr^A and tr^B are defined in Equations (39) and (40); $ccs(z_j, \Omega)$ is the Child Care Subsidy (CCS), with subsidy rate sr_j defined in Equation (41); and $pen(z_j^R, \Omega)$ is the Age Pension from Equation (44). In the company tax (T^K) equation, L refers to the total labor supply in efficiency units, which is the aggregate of LM and LF .

Definition of competitive equilibrium. Given the household, firm, and government policy parameters, the demographic structure, the goods and factor prices, a steady-state equilibrium at time t is characterized by the following conditions:

- (a) The individual household decisions $\{c(z_j, \Omega_t), n(z_j, \Omega_t), a_+(z_j, \Omega_t)\}_{j=1}^J$ solve the household problems (48), (53), and (55);
- (b) The firm chooses labor and capital inputs to solve its profit maximization problem (35);
- (c) The government's periodic budget constraint (45) is satisfied;
- (d) The factor markets clear: $K_t^s = K_t^d = K_t$ and $L_t^s = L_t^d = L_t$, where

$$K_t^s = A_t - B_t - B_{F,t} \quad (58)$$

$$L_t^s = LM_t + LF_t; \quad (59)$$

³⁴Since the household mass is normalized to one, aggregate variables are equivalent to per-household variables. Per capita variables in each period t can be obtained by normalizing the aggregate values by the total population (i.e., the number of adults).

(e) The goods market clears

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

where I_t is investment; NX_t is the trade account, with $NX_t > 0$ denoting a trade account surplus; $B_{F,t}$ represents foreign capital under the no-arbitrage condition for a small open economy, where $B_{F,t} > 0$ indicates a capital outflow (or a capital account deficit);³⁵

(f) The total bequest, BQ_t , is the total untapped private wealth left by deceased households at the beginning of time t . Given the known survival probabilities, BQ_t can be accurately predicted:³⁶

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

where $\psi_{j,\lambda}$ is the conditional survival probability for household type λ at age j .³⁷

I assume that bequests are uniformly distributed among living working-age households. Thus, the amount of bequest received by a household aged j at time t is:

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

4.9 Welfare

Welfare refers to ex-ante welfare, which concerns the long-run well-being of newborn households under the veil of ignorance. This theoretical construct assumes that households, upon entering the economy, possess perfect information about the economic environment, including their own preferences, constraints, technology, and policy parameters. All policy reforms are anticipated and fully incorporated into the households' decision processes over their life cycles. That is, there is no element of surprise.³⁸

The normative welfare criterion is utilitarian. No additional assumptions about the societal aversion to inequality are imposed. I assess welfare changes using the Consumption Equivalent Variation (CEV), which measures the consumption changes necessary to make a newborn household in the benchmark economy as well off as its counterpart in the reformed economy. Formally, for a household type z_j , I define its CEV at time $t = T$ as:

$$W(c_T, l_T) = W(c_0 \times (1 + CEV(z_j, \Omega_T)), l_0) \quad (60)$$

³⁵See Section J in the Appendix for a detailed explanation of $B_{F,t}$ and NX_t .

³⁶Uniform accidental bequests ensure that the wealth of deceased households is distributed among the living, thus maintaining aggregate wealth. Alternative methods to handle leftover wealth include introducing an annuity market, where households fully annuitize their savings through contracts with financial intermediaries. However, annuity markets remain relatively small worldwide, including in Australia where only 3.5% of assets in pension accounts are held in annuities, with a limited number of providers (see 2023 Treasury's discussion paper). Another approach involves incorporating a parent-child linkage in the household's objective function. However, this is computationally expensive as it requires an additional continuous state element to track wealth bequeathed to children, increasing the dimensionality of the problem. Therefore, given the relatively small size of aggregate accidental bequests and the study's focus on child benefits aimed at supporting low-income parents, introducing bequest heterogeneity would add unnecessary complexity.

³⁷For a married household ($\lambda \in \{1, 2\}$), $\psi_{j,\lambda} = 1 - (1 - \psi_j^m)(1 - \psi_j^f)$ is the probability that both spouses survive and the household maintains its marital status.

³⁸Non-newborn households aged $j = 2, \dots, J$ living in the reform period t would not have anticipated the reform. These households already committed to their initial decisions under the status quo regime when they entered the economy in period $t - j + 1$. Thus, the reform exerts different welfare effects on these cohorts living through the transition. However, due to computational limitations, I do not study transitional dynamics of reformed economies in this paper.

where $W(c_t, l_t)$ represents the optimal expected lifetime utility, $V(z_j, \Omega_t)$, expressed as a function of the optimal consumption, $c_t := c_t(z_j, \Omega_t)$, and leisure, $l_t := l_t(z_j, \Omega_t)$, in period t . Given this definition, together with the household preferences from Subsection (4.2), we can derive a closed-form solution for CEV :

$$CEV(z_j, \Omega_T) = \left[\left(\frac{V(z_j, \Omega_T)}{V(z_j, \Omega_0)} \right)^{\frac{1}{\nu \left(1 - \frac{1}{\gamma}\right)}} - 1 \right] \times 100 \quad (61)$$

where Ω_0 and Ω_T denote the policy parameters in the status quo at time $t = 0$ and the new regime at time $t = T$, respectively.

The total CEV at time T is obtained by aggregating households' CEV s across z_j , weighted by their population share, $\mu_{j,T}$:

$$CEV_{total} = \sum_{j=1}^J \sum_{\Lambda \times \Theta} \int_{A \times H \times S^2} CEV(z_j, \Omega_T) \mu_{j,T} d\Phi(z_j)$$

An optimal policy over a policy parameter space $x \in X$ is formally defined as:

$$x^* = \operatorname{argmax} \{CEV_{total}\}$$

Explanation: To illustrate how the CEV method captures welfare changes, consider a simple two-agent economy. Both agents, A and B , have identical CRRA preferences and differ only with respect to their initial levels of consumption. Suppose the status quo (SQ) endowments are $\{A : 25, B : 75\}$, making A relatively worse off. Two alternative regimes are introduced: Regime 1 ($R1$), where a transfer is made from A to B , and Regime 2 ($R2$), where the opposite policy is pursued. The transfer amounts are identical in both cases. Figure 9 shows the utility possibility frontier, the Social Welfare Functions (SWF), and the implied individual CEV s for the status quo and the two reformed economies.

The utilitarian SWF accounts for the concavity of the household utility function. This implies that, for the same amount of transfer, redistributing from the worse-off agent A to the better-off agent B deteriorates overall welfare, and vice versa. Assuming a unit mass population, the total CEV in Regime 1 is $CEV_{R1} = 0.5(-40\%) + 0.5(13.33\%) = -13.34\%$, representing an average decline in consumption of 13.34% relative to the status quo. Conversely, the same transfer from B to A in Regime 2 results in $CEV_{R2} = 13.34\%$, a welfare improvement equivalent to an average increase of 13.34% in consumption. This simple example helps explain how the welfare changes of single mothers, as a vulnerable group, could significantly influence the overall welfare outcomes throughout most policy experiments conducted in this study.

Notably, if the distribution of agents is not uniform, a policy move such as $R1$ could be welfare-improving at the aggregate level. Consider a case where A makes up only 20% of the population. This leads to $CEV_{R1} = 0.2(-40\%) + 0.8(13.33\%) \approx 2.67\%$, an increase in the overall welfare while the losses are concentrated in A . Since vulnerable groups, such as single mothers, often form a minority of the population, this highlights the need to carefully consider the distribution of welfare changes in policy evaluations.

4.10 Welfare decomposition

Adapting the approach of Bhandari et al. (2021), I decompose welfare changes in consumption and leisure into 3 components: *Efficiency (or Level)*, *Distribution (or Equity)*, and *Insurance*.

Suppose an economy is in its pre-reform (initial) steady state at time $t = 0$, and a post-reform (final) steady state at time $t = T$. Let $c_t := c(z_j, \Omega_t)$ and $l_t := 1 - n(z_j, \Omega_t)$ be the optimal consumption and leisure allocation for a household aged j with state vector z at time t . Suppressing the age subscript j , the decomposition of

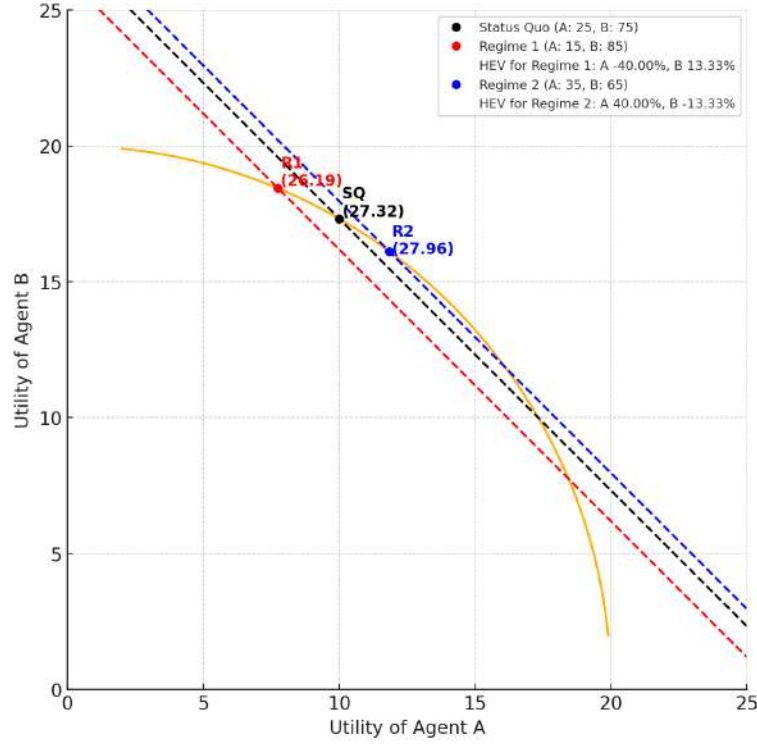


Figure 9: **Example Utilitarian Social Welfare Function and Consumption Equivalent Variation (CEV).**

Notes: Each agent i 's preference, for $i \in \{A, B\}$, is represented by $u(c_i) = \frac{c_i^{1-1/\gamma}}{1-1/\gamma}$. The initial allocation is $(c_A, c_B) = (25, 75)$, making A poorer in consumption. Regime 1 transfers 10 units of consumption from A to B, and vice versa for regime B. Dashed lines represent the Social Welfare Function for each case.

consumption and leisure in time t is as follows:

$$c_t = E(c_t) \times \frac{E_i(c_t)}{E(c_t)} \times \frac{c_t}{E_i(c_t)} = C_t \times d_t^c \times (1 + \epsilon_t^c) \quad (62)$$

$$l_t = E(l_t) \times \frac{E_i(l_t)}{E(l_t)} \times \frac{l_t}{E_i(l_t)} = E(l_t) \times d_t^l \times (1 + \epsilon_t^l) \quad (63)$$

For a household of age j and state vector z , the first term $C_t = E(c_t)$ in the consumption equation captures the expected or average consumption level. In the second term, i represents a characteristic that the household shares with a subset of the population, such as family type λ or education θ . Denoting a group by its characteristic i , $d_t^c = \frac{E_i(c_t)}{E(c_t)}$ is therefore the household's ex-ante consumption share, which is the average consumption of group i relative to the population average. The last term, $1 + \epsilon_t^c = \frac{c_t}{E_i(c_t)}$, is the household's ex-post consumption risk, defined as the realized consumption level relative to its expected consumption as a member of group i . The decomposition for leisure in Equation (63) follows a similar structure, with its components interpreted analogously.

Following the scheme above, the consumption and leisure changes between the two economies can be written as:

$$1 + \Delta c = \frac{c_T}{c_0} = \underbrace{\frac{C_T}{C_0}}_{(a) \text{ Efficiency/Level}} \times \underbrace{\frac{d_T^c}{d_0^c}}_{(b) \text{ Distribution/Equity}} \times \underbrace{\frac{1 + \epsilon_T^c}{1 + \epsilon_0^c}}_{(c) \text{ Insurance}} \quad (64)$$

$$1 + \Delta l = \frac{l_T}{l_0} = \frac{E(l_T)}{E(l_0)} \times \frac{d_T^l}{d_0^l} \times \frac{1 + \epsilon_T^l}{1 + \epsilon_0^l} \quad (65)$$

Equations (64) and (65) express consumption and leisure changes due to a reform in terms of three com-

ponents. Consider the case of consumption. Term (a), $\frac{C_T}{C_0}$, is the change in expected or average consumption level for a household of age j in the new regime relative to the status quo, reflecting the efficiency or level effect. Aggregating welfare changes from these consumption level changes over the life cycle captures the *allocative efficiency effect*. Term (b), $\frac{d_T^c}{d_0^c}$, is the change in the ex-ante consumption share, capturing the reform's *distributional (or equity) effect*. Finally, term (c), $\frac{1 + \epsilon_T^c}{1 + \epsilon_0^c}$, is the change in the degree to which the household's realized consumption deviates from its expectation (for being in group i), reflecting the difference in its ex-post consumption risks between time 0 and T , and thus the *insurance effect* of the reform.

From Equation (64), post-reform consumption allocations can be decomposed into three terms, reflecting the different stages of changes:

$$\hat{c}_E = \left(\frac{C_T}{C_0} \right) \times c_0 \quad (66)$$

$$\hat{c}_D = \left(\frac{C_T}{C_0} \times \frac{d_T^c}{d_0^c} \right) \times c_0 = \frac{d_T^c}{d_0^c} \times \hat{c}_E \quad (67)$$

$$\hat{c}_I = \left(\frac{C_T}{C_0} \times \frac{d_T^c}{d_0^c} \times \frac{1 + \epsilon_T^c}{1 + \epsilon_0^c} \right) \times c_0 = \frac{1 + \epsilon_T^c}{1 + \epsilon_0^c} \times \hat{c}_D = c_T \quad (68)$$

The case of leisure from Equation (65) is analogous:

$$\hat{l}_E = \left(\frac{E(l_T)}{E(l_0)} \right) \times l_0 \quad (69)$$

$$\hat{l}_D = \left(\frac{E(l_T)}{E(l_0)} \times \frac{d_T^l}{d_0^l} \right) \times l_0 = \frac{d_T^l}{d_0^l} \times \hat{l}_E \quad (70)$$

$$\hat{l}_I = \left(\frac{E(l_T)}{E(l_0)} \times \frac{d_T^l}{d_0^l} \times \frac{1 + \epsilon_T^l}{1 + \epsilon_0^l} \right) \times l_0 = \frac{1 + \epsilon_T^l}{1 + \epsilon_0^l} \times \hat{l}_D = l_T \quad (71)$$

I then proceed by decomposing the overall welfare changes into two sets of components. The first set comprises effects stemming from the changes in consumption from c_0 to c_T . Analogously, the second set addresses changes in leisure from l_0 to l_T .

The welfare effect due to consumption changes (Δc) is measured by holding leisure fixed at its status quo level l_0 , and is decomposed into consumption allocative efficiency effect (CEV_{CE}), consumption distributive/equity effect (CEV_{CD}), and consumption insurance effect (CEV_{CI}). Given the CEV definition (60), and the post-reform consumption components in (66), (67), and (68), these effects are formally defined as follows:

$$\text{Allocative efficiency effect of } \Delta c : V_{CE} := W(\hat{c}_E, l_0) = W(c_0 \times (1 + CEV_{CE}), l_0) \quad (72)$$

$$\text{Distributive/equity effect of } \Delta c : V_{CD} := W(\hat{c}_D, l_0) = W(\hat{c}_E \times (1 + CEV_{CD}), l_0) \quad (73)$$

$$\text{Insurance effect of } \Delta c : V_{CI} := W(c_T, l_0) = W(\hat{c}_D \times (1 + CEV_{CI}), l_0) \quad (74)$$

where I suppress notations for the state vector z and policy parameter vector Ω . After accounting for the consumption effects, consumption is held constant at its new optimal allocation, c_T . The leisure allocative efficiency effect (CEV_{LE}), leisure distributive/equity effect (CEV_{LD}), and leisure insurance effect (CEV_{LI}) due to changes in leisure (Δl) are then defined as:

$$\text{Allocative efficiency effect of } \Delta l : V_{LE} := W(c_T, \hat{l}_E) = W(c_T \times (1 + CEV_{LE}), l_0) \quad (75)$$

$$\text{Distributive/equity effect of } \Delta l : V_{LD} := W(c_T, \hat{l}_D) = W(c_T \times (1 + CEV_{LD}), \hat{l}_E) \quad (76)$$

$$\text{Insurance effect of } \Delta l : V_{LI} := W(c_T, l_T) = W(c_T \times (1 + CEV_{LI}), \hat{l}_D) \quad (77)$$

The solutions to Equations (72)-(77) provide the decomposed welfare effects of consumption and leisure changes in the final steady state at time T . Based on the household preferences outlined in Subsection 4.2, the

closed-form solutions for these effects are expressed as:

$$\begin{aligned}
CEV_{CE} &= \left[\left(\frac{V_{CE}(z_j, \psi_T)}{V_0(z_j, \psi_0)} \right)^{\frac{1}{\nu(1-\frac{1}{\gamma})}} - 1 \right] \times 100 & CEV_{CD} &= \left[\left(\frac{V_{CD}(z_j, \psi_T)}{V_{CE}(z_j, \psi_T)} \right)^{\frac{1}{\nu(1-\frac{1}{\gamma})}} - 1 \right] \times 100 \\
CEV_{CI} &= \left[\left(\frac{V_{CI}(z_j, \psi_T)}{V_{CD}(z_j, \psi_T)} \right)^{\frac{1}{\nu(1-\frac{1}{\gamma})}} - 1 \right] \times 100 & CEV_{LE} &= \left[\left(\frac{V_{LE}(z_j, \psi_T)}{V_{CI}(z_j, \psi_T)} \right)^{\frac{1}{\nu(1-\frac{1}{\gamma})}} - 1 \right] \times 100 \\
CEV_{LD} &= \left[\left(\frac{V_{LD}(z_j, \psi_T)}{V_{LE}(z_j, \psi_T)} \right)^{\frac{1}{\nu(1-\frac{1}{\gamma})}} - 1 \right] \times 100 & CEV_{LI} &= \left[\left(\frac{V_{LI}(z_j, \psi_T)}{V_{LD}(z_j, \psi_T)} \right)^{\frac{1}{\nu(1-\frac{1}{\gamma})}} - 1 \right] \times 100
\end{aligned}$$

5 Calibration

The economy is modeled on a balanced growth path, where aggregate consumption, investment, and capital grow at a constant rate of $g = g_A + g_N$, while the time endowment for work and leisure is fixed. The parametric functions for preferences and technology are chosen to reflect the observed macroeconomic facts and to ensure comparability with the past research on related issues.

I calibrate the model to match key statistics of the Australian economy from 2012 to 2018, a period marked by relative stability in macroeconomic indicators, including household consumption and asset growth.³⁹ Externally calibrated parameters are summarized in Table 2. These parameters are based on estimates from the HILDA survey and widely used estimates in similar studies on Australia. Additional data sources include statistics from the Australian government bodies, such as the Australian Bureau of Statistics (ABS), and international organizations like the World Bank. The remaining micro and macro parameters are calibrated internally to match key model moments with corresponding data moments. These parameters and their calibration targets are summarized in Table 3.

To evaluate the model's performance, I compare a set of targeted and non-targeted data moments with their model-generated counterparts. Results, as shown in Table 4, indicate that the benchmark model generally demonstrates a good fit with key aggregate empirical characteristics of the Australian economy. However, some discrepancies are notable, particularly in the life cycle profile of labor force participation for mothers. I discuss the likely causes of these discrepancies and suggest potential solutions for future work.

5.1 Demographics

A model period is one year. Households enter the model economy as workers at age 21 ($j = 1$), retire at age 65 ($j = J_R = 45$), and can live up to a maximum age of 100 ($j = J = 80$).⁴⁰ The time-invariant average conditional survival probabilities for males and females ($\psi_{j,m}$ and $\psi_{j,f}$) are calculated using data from the 2001-2019 ABS Life Tables.

The growth rate of newborn households is kept constant at $g_N = 1.6\%$, which reflects the average annual population growth rate in Australia from 2012-2018 ([Profile of Australia's population, AIHW 2024](#)). Newborn household masses by family type, $\pi(\lambda)$, are estimated shares by marital and parental statuses for households aged 50-65 from HILDA data. Married households comprise 59% of the newborns, with 88% being parents, leading to $\pi(1) = 0.52$ and $\pi(2) = 0.06$. Single households, 60% of whom are women, make up the remaining 41%, resulting in $\pi(3) = 0.17$ and $\pi(4) = 0.25$.

³⁹For further details, see the [RBA report on wealth and consumption indicators](#). Additionally, this period is suitable because it allows for the use of 2018 policy parameters for the FTB and CCS, which underwent significant reforms during this period (e.g., changes to the FTB-A payment rates, income-test thresholds, FTB-B primary earner thresholds, and other adjustments to tax offsets to streamline the system), thus offering a more accurate representation of the current Australian tax and child benefit systems.

⁴⁰I set productivity to zero from age J_R onward, making retirement mandatory.

Parameter	Value	Target
<i>Demographics</i>		
Maximum lifespan	$J = 80$	Age 21-100
Retirement age	$J_R = 45$	Age Pension age 65
Population growth	$g_N = 1.6\%$	Average (ABS 2012-2018)
Survival probabilities	ψ_m, ψ_f	Life Tables (ABS 2010-2019)
Measure of newborns	$\{\pi(\lambda_1), \pi(\lambda_2), \pi(\lambda_3), \pi(\lambda_4)\} = \{0.52, 0.06, 0.17, 0.25\}$	Marital and parental status at age 50-65 (HILDA 2012-2018)
<i>Technology</i>		
Labor aug. tech. growth	$g_A = 1.3\%$	Prod. growth per hour (World Bank 2012-2018)
Output share of capital	$\alpha = 0.4$	Treasury 2019
Real interest rate	$r = 4\%$	World Bank 2012-2018
<i>Households</i>		
Relative risk aversion	$\sigma = \frac{1}{\gamma} = 3$	Standard values 2.5-3.5
Exogenous male labor hours	n_λ^m	Age-profiles of average work hours for male workers (HILDA)
Male human capital profile	h_λ^m	Age-profiles of median male hourly wages (HILDA)*
<i>Education</i>		
Measure of $\{\theta_L, \theta_H\}$ type households	$\{\pi(\theta_L), \pi(\theta_H)\} = \{0.7, 0.3\}$	College-to-HS ratio (ABS 2018)
<i>Fiscal policy</i>		
Income tax progressivity	$\tau = 0.2$	Tran and Zakariyya 2021a
Consumption tax	$\tau^c = 8\%$	$\tau_c \frac{C}{Y} = 4.5\%$
Company profit tax	$\tau^k = 10.625\%$	$\tau^k \left(\frac{Y - wL}{Y} \right) = 4.25\%$
Government debt to GDP	$\frac{B}{Y} = 20\%$	Average (CEIC 2012-2018)
Government general purchase	$\frac{Y}{G} = 21\%$	Net of FTB, CCS and Age Pension (APH)
FTB, CCS, and Pension parameters		HILDA tax-benefit model

Table 2: Externally calibrated parameters

Notes: (*) The age-profile of median male hourly wages is estimated by regressing $\log(\text{wage})$ on quadratic age terms and four dummy variables for gender, marital status, employment type, and time. All hourly wage estimates are then normalized by the average hourly wages of 21-year-old, low-education, married men working full-time.

Parameter	Value	Target
<i>Households</i>		
Discount factor	$\beta = 0.99$	Savings rate 5%-8% (ABS 2013-2018)
Taste for consumption	$\nu = 0.55$	Female work hours = 28.2 per week (HILDA 2012-2018)
<i>Fixed cost function</i>		
Maximum fixed cost	$\{\chi_{\lambda=\{1,4\},\ell}^{max}, \chi_{\lambda=2,\ell}^{max}\}$	
Full-time ($\ell = 2$)	$\{0.645, 0.650\}$	LFP of mothers (71.1%) and non-mothers (73.4%)
Part-time ($\ell = 1$)	$\{0.543, 0.645\}$	FT share of mothers (53.6%) and non-mothers (68.9%)*
<i>Female human capital</i>		
Depreciation rate	$\delta_h = 0.074$	Male-female wage gap at age 50**
Accumulation rate for:	$(\xi_{1,\theta,\ell}, \xi_{2,\theta,\ell})$	
Low-Ed working part-time	(0.01, 0.00045)	FT wage profile of low-ed male***
Low-Ed working full-time	(0.0275, 0.001125)	PT wage profile of low-ed male
High-Ed working part-time	(0.04, 0.0015)	FT wage profile of high-ed male
High-Ed working full-time	(0.065, 0.0025)	PT wage profile of high-ed male
<i>Technology</i>		
Capital depreciation rate	$\delta = 0.07172$	$\frac{K}{Y} = 3.2$ (ABS 2012-2018)
<i>Transitory shocks</i>		
Persistence parameter	$\rho = 0.98$	Literature
Variance of shocks	$\sigma_v^2 = 0.01425$	Gini coefficient of male wages at age 21, $GINI_{j=1,m} = 0.35$
<i>Fiscal policy</i>		
Maximum pension payment	$pen^{max} = 30\% \times Y$	Pension share of GDP, $\frac{\mathcal{P}_t}{Y_t} = 2.4\%$ (Treasury 2021)

Table 3: Internally calibrated parameters

Notes: (*) See Subsection for details on the calibration of the slope parameter $\chi_{\lambda,\ell}^s$ and the inflection point \bar{j}_λ of the age profiles of fixed costs. (**) Age 50 is chosen to allow sufficient time for δ_h to take effect on female labor supply decisions. (***) I calibrate the female human capital accumulation and depreciation rates for a type $\{\theta, \ell\}$ woman so that her age-profile of wages aligns with that of her male counterpart if she works continuously without time off. The target male moments (i.e., male age-profiles of wages) are HILDA estimates for each $\{\theta, \ell\}$ pair. Some adjustments (e.g., excluding data near retirement age) were made to better fit the male profiles, particularly for groups with noisier data, such as single men.

5.2 Preferences

The subjective discount factor is calibrated to $\beta = 0.99$, ensuring that the household savings rate stays between 5% and 8%, as reported by [ABS National Accounts statistics](#). The elasticity of intertemporal substitution is set at $\gamma = \frac{1}{3}$, within the standard range of values in the literature.⁴¹

The taste-for-consumption parameter $\nu = 0.55$ is calibrated to align the model's implied average female weekly work hours with the observed average of 28 hours. The fixed time cost parameters from Equation (34) are calibrated to match labor force participation rates and the full-time employment shares for both mothers and non-mothers with observed data.

Let λ_m represent households with mothers ($\lambda = \{1, 4\}$), and λ_{nm} those without mothers ($\lambda = \{2, 3\}$). The calibration of fixed cost parameters involves two steps. First, the maximum fixed cost parameters for part-time ($\chi_{\lambda_i, \ell=1}^{max}$) and full-time work ($\chi_{\lambda_i, \ell=2}^{max}$) for each $i \in \{m, nm\}$ are jointly calibrated to match the model's labor force participation rates for mothers (LFP_m) and non-mothers (LFP_{nm}) to observed data. Then, the full-time-to-part-time fixed cost ratios for mothers $\left(\frac{\chi_{\lambda_m, 2}^{max}}{\chi_{\lambda_m, 1}^{max}}\right)$ and non-mothers $\left(\frac{\chi_{\lambda_{nm}, 2}^{max}}{\chi_{\lambda_{nm}, 1}^{max}}\right)$ are calibrated so that their respective full-time employment shares (FT_m and FT_{nm}) in the model align with their data counterparts. Specifically, in the first step, the calibration sets $\chi_{\lambda_i, 1} = \chi_{\lambda_i, 2}$, and in the second step, $\chi_{\lambda_i, 1}$ is adjusted, while holding $\chi_{\lambda_i, 2}$ constant at the values obtained in the first step. This process results in $\{\chi_{\lambda_m, 1}^{max}, \chi_{\lambda_m, 2}^{max}\} = \{0.645, 0.650\}$ for mothers and $\{\chi_{\lambda_{nm}, 1}^{max}, \chi_{\lambda_{nm}, 2}^{max}\} = \{0.543, 0.645\}$ for non-mothers. Furthermore, I assume that married households ($\lambda = \{1, 2\}$) are perfectly altruistic, meaning couples share fixed time costs $\chi_{\lambda, \ell}$ equally.

The parameters for steepness ($\chi_{\lambda, \ell}^s$) and inflection point (\bar{j}_λ) of the fixed cost function are then adjusted to capture the declining rates and peaks of life cycle profiles of full-time employment shares for both mothers and non-mothers.⁴² For mothers, I set $\{\chi_{\lambda_m, 1}^s, \chi_{\lambda_m, 2}^s\} = \{0.002, 0\}$ and $\bar{j}_{\lambda_m} = 10$, while for non-mothers, $\{\chi_{\lambda_{nm}, 1}^s, \chi_{\lambda_{nm}, 2}^s\} = \{0.001, 0\}$ and $\bar{j}_{\lambda_{nm}} = 50$.

5.3 Endowments

Labor productivity. Every adult household member is subject to idiosyncratic transitory earnings shocks, η^i for $i \in \{m, f\}$. These shocks follow an identical AR(1) process with persistence ρ and the variance of innovation σ_v^2 . I set $\rho = 0.98$ to stay within the bounds of common values in the literature, and $\sigma_v = 0.01425$ to achieve a Gini index of 0.35 for the efficiency wage distribution of newborn male workers aged $j = 1$ in the model. This configuration results in a Gini coefficient of 0.3766 (non-targeted) for the working-age male population.⁴³

The Rouwenhorst method is employed to discretize the shock values into three grid points $\{0.4281, 1, 2.3358\}$ with the following Markov transition probabilities⁴⁴

$$\begin{bmatrix} 0.9801 & 0.0198 & 0.0001 \\ 0.0099 & 0.9802 & 0.0099 \\ 0.0001 & 0.0198 & 0.9801 \end{bmatrix}$$

I assume two education types—low (θ_L) and high (θ_H)—realized at birth, representing individuals with at most a high school degree and those with a bachelor's degree or higher qualifications, respectively. Education θ influences the parameters $\{\xi_{1, \theta, \ell}, \xi_{2, \theta, \ell}\}$ that govern human capital trajectories, thereby determining effective

⁴¹ $\beta = 0.99$ yields a growth-adjusted discount factor $\tilde{\beta} = \beta(1 + g)^{\nu(1 - \frac{1}{\gamma})} = 0.9807$ for the balanced-growth path steady-state economy.

⁴²The model-generated life cycle profiles of full-time employment shares relative to the data are reported in Table 4.

⁴³More precisely, σ_v is calibrated to match the Gini index of the model's male efficiency wage distribution with that of the observed male earnings distribution, which includes variations in work hours. The rationale is that the exogenous male work hour profiles employed in the model are normalized average values. Since the model lacks an endogenous source of hour variation for men, I use the transitory shock process that drives the male efficiency wages to also capture the exogenous work hour fluctuations.

⁴⁴The Rouwenhorst method matches exactly the first and second moments of the continuous process but cannot capture higher-order moments of shocks (e.g., skewness and kurtosis), which are important for an accurate modeling of the magnitude and probability of extreme earnings shocks.

wages. The proportions 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](#).

I abstract from men’s labor supply decisions and assume they always work full-time. Their age-profiles of normalized average work hours (n_λ^m) are externally estimated by family type.⁴⁵

I estimate hourly wage age-profiles from HILDA data for single and married males. They serve as proxies for male age profiles of human capital h_λ^m in the model. Female human capital $h_{\theta,\ell}^f$ evolves endogenously over the life cycle, governed by education θ and employment status ℓ . Human capital gain parameters for women, $\{\xi_{1,\theta,\ell}, \xi_{2,\theta,\ell}\}$, are calibrated so that the life cycle paths of human capital for single and married women mirror those of their male counterparts should they choose to work continuously without time off. The parameter values for each $\{\theta, \ell\}$ pair are presented in Table 3.

Children. Children are deterministic and exogenous. Based on HILDA survey data, which shows that a plurality of parents (42%) have two children, the model households are assumed to have two children over their lifetimes.⁴⁶ Heterogeneity in the timing of childbirth is linked to the household’s education level θ . The [longitudinal study of Australian children \(LSAC\) annual statistics report in 2017](#) shows that the largest share of first-time mothers aged 15-19 concentrates within the low-education group (67.7%), while only around 10% of first-time mothers aged 25-37 have low education. In contrast, nearly half of first-time mothers in the older age group hold a bachelor’s degree or higher. Reflecting this fact, I assign the first child’s birth to low-education (θ_L) parents at age 21 ($j = 1$, the youngest in the model), and to high-education (θ_H) parents at age 28 ($j = 8$). In both groups, the second child arrives three years after the firstborn, at age 24 and 31, respectively.⁴⁷ Moreover, for tractability, and based on the observation that women constitute the majority of lone parents (87.21%) in the sample, I assume that all single women have children, whereas single men are childless.

Child care cost. I assume that there is no informal child care and that formal care services operate in a perfectly competitive market environment with uniform quality and pricing, thus abstracting from variations in regional costs and types of child care providers. Using a conservative estimate of \$12.5 per hour, the cost of child care amounts to 52% of the average hourly wage of a 21-year-old male in the model. The total formal child care costs for a household aged j is the sum of costs for all dependent children. I further assume that child care costs (κ) decline once a child reaches six years of age (school age). More precisely, working mothers pay the full cost of formal child care for children aged 0-5 years, and one-third of the cost thereafter. This reduction reflects the assumption that public schools are free, and that parents only incur expenses for out-of-school-hours (OOSH) care and extracurricular activities.⁴⁸

5.4 Technology

The production function is $Y = K^\alpha (AL)^{1-\alpha}$, where the capital output share is set at $\alpha = 0.4$ for Australia. The labor-augmenting technology A is normalized to 1 in the benchmark economy. Given Australia’s average

⁴⁵Estimates from HILDA show that male labor supply is stable across parental and marital statuses. Empirical exercises using logistic regressions of workforce participation on lagged FTB benefits and demographic controls also suggest minimal work disincentives from family benefits for men. For example, a \$10,000 increase in the FTB transfer is associated with only a 1 percentage point (*pp*) decline in participation for fathers (*p*-value = 0.18), compared to a statistically significant 4.3*pp* drop in participation for mothers. Similarly, [Doiron and Kalb \(2004\)](#) find that increases in child care costs have a negligible effect on male labor supply in Australia. Empirical evidence thus far points to a highly inelastic male labor supply. Hence, for computational feasibility and given the model’s focus on women, male labor supply is treated as exogenous.

⁴⁶The proportion of parents with two children is based on a restricted sample of older households (aged 50 and above). This ensures that the statistics reflect the number of children households have over their life cycles. The data shows that 12% of parents have one child, 42% have two, 28% have three, and the remainder have four or more.

⁴⁷According to the [Australian Institute of Health and Welfare \(AIHW\) report](#), child spacing remains approximately three years, although the average age of mothers at the birth of their first and second children rose from 27.9 and 31 years in 2009 to 29.4 and 31.9 years in 2019.

⁴⁸OOSH services operate before school (6:30am-9am), after school (3pm-6pm), and during vacation periods (7am-7pm). I reduce the cost to one-third of the original to account for the fact that school-age children spend less time in child care on average (only 40% of children aged 6-8 participate in any form of child care, and the rate declines to 20% by age 12). For further information on child care usage, see the [AIFS report on child care and early childhood education in Australia](#), and for information on the average cost of care for a child, refer to the [2005 DSS report on costs of children](#). I use recent information for the hourly child care costs and assume the cost ratio for school-age children relative to preschool-age children has remained stable since 2005.

annual GDP growth per hour worked of 1.3%, the labor-augmenting technology growth rate g_A is set at 0.013. Using the firm’s first-order conditions (36) and targeting a capital-to-GDP ratio of $K/Y = 3.2$, the capital depreciation rate δ is derived to be 0.0717.

5.5 Fiscal policy

Taxes. The progressivity parameter is set at $\tau = 0.2$, following [Tran and Zakariyya 2021a](#). The tax scale parameter ζ , which controls the overall size of the tax system (or tax burden), is used as an endogenous variable to balance the budget in all policy experiments. The consumption tax rate $\tau^c = 8\%$ targets a consumption tax share of GDP $\frac{\tau^c C}{Y}$ of 4.5%, based on an average consumption-to-GDP ratio $\frac{C}{Y} = 56.3\%$ according to the 2012-2018 ABS data. The company profit tax rate τ^k is calculated to be 10.625% such that the company tax share of GDP, $\tau^k \left(\frac{Y - wL}{Y} \right) = 4.25\%$, where $\frac{wL}{Y} = 1 - \alpha = 0.6$.

Family Tax Benefit and Child Care Subsidy. The policy parameters—including base and maximum payment rates, income-test thresholds, and phase-out rates—for the Family Tax Benefit (FTB) Parts A and B and the Child Care Subsidy (CCS) programs are based on the actual 2018 Australian government policy settings. See Subsection H.2 in the Appendix for detailed information.

Means-tested Age Pension. The Age Pension’s income and assets test thresholds, along with their respective phase-out rates, are based on 2018 values. In the benchmark economy, the maximum pension payout p^{max} is calibrated to be 30% of per capita income to achieve a total pension share of GDP of 2.4%, in line with the [Treasury 2021 Retirement Income Review](#).

General government expenditure and debt. General government expenditure G includes all government spending except the explicitly modeled child benefit programs (FTB and CCS) and the Age Pension, which respond endogenously to counterfactual reforms. According to [the Budget Review 2020-21](#), total government expenditure is 25% of GDP. After accounting for the estimated expenditures on the FTB and CCS (1.4%) and the Age Pension (2.4%), the exogenous general expenditure is 21.2% of GDP. Public debt B is set at 20% of GDP, reflecting the average public debt share prior to the COVID-19 pandemic.

5.6 Benchmark economy

The model performance is assessed by comparing key aggregate and life cycle moments generated by the model with their corresponding data counterparts.

Aggregate macro variables. I examine targeted and non-targeted aggregate macroeconomic moments in the benchmark economy. Table 4 demonstrates that the benchmark model generally aligns well with the observed data at the aggregate level.

Life-cycle profiles. Figure 10 presents age-profiles of labor force participation rates (non-targeted) and full-time employment shares (targeted) for mothers and non-mothers, comparing model-generated moments with observed data.

The benchmark model effectively captures the general patterns of full-time employment share profiles for both mothers and non-mothers. However, it misses the dip in mothers’ profiles observed between ages 30 and 40. For non-mothers, the model’s implied participation profile closely tracks the data but slightly understates participation by 2 to 5 percentage points (*pp*) before age 35 and overstates it by a similar margin after age 45.

For mothers, the model faces greater challenges. While aggregate labor force participation rates align well with the data, the benchmark model predicts substantially higher participation among mothers during childbearing and rearing years, followed by a sharp decline after their children become independent.

A key factor contributing to this abrupt drop in female participation is the assumption of exogenous and deterministic children. This assumption restricts childbirth to the first 10 years of working life and excludes older mothers, creating a simplified dynamic. Children introduces child care costs and consumption penalties as they increase household size. Consequently, as children leave the household, the resulting positive income

Moments	Model	Data	Source
<i>Targeted</i>			
Capital, K/Y	3.2	3-3.3	ABS (2012-2018)
Savings, S/Y	8.5%	5-8%	ABS (2013-2018)
Female work hours	23.6	28.2	HILDA (2012-2018)
<i>LFP</i> of mothers	73.3%	71.1%	HILDA (2012-2018)
<i>LFP</i> of non-mothers	74.2%	73.4%	HILDA (2012-2018)
<i>FT</i> share for working mothers	54.6%	53.6%	HILDA (2012-2018)
<i>FT</i> share for working non-mothers	71%	68.9%	HILDA (2012-2018)
Consumption tax, T^C/Y	3.6%	4.50%	APH Budget Review
Corporate profit tax, T^K/Y	4.25%	4.25%	APH Budget Review
Age Pension, P/Y	2.3%	2.4%	ABS (2012-2018)
Gini coefficient (male aged 21)	0.35	0.35	HILDA (2012-2018)
<i>Non-targeted</i>			
Consumption, C/Y	45.5%	54-58%	ABS (2012-2018)
Investment, I/Y	32.3%	24-28%	ABS (2013-2018)
Female <i>LFP</i>	70.7%	71.5%	HILDA (2012-2018)
Scale parameter, ζ	0.8978	0.7237	Tran and Zakariyya 2021b
Income tax, T^I/Y	4.9%	11%	APH Budget Review
Child-related transfers (FTB + CCS)	1%	1.45%	ABS (2012-2018)

Table 4: **Key macroeconomic variables: Model vs. Data moments**

Notes: (*) Multiple sources, including my estimates using HILDA survey data, confirm these ranges of participation rates for mothers. (**) I target a Gini coefficient of 0.35 for the male earnings distribution at birth (age 21 or $j = 1$). This results in a Gini coefficient of 0.3766 for the male earnings distribution over the entire working age.

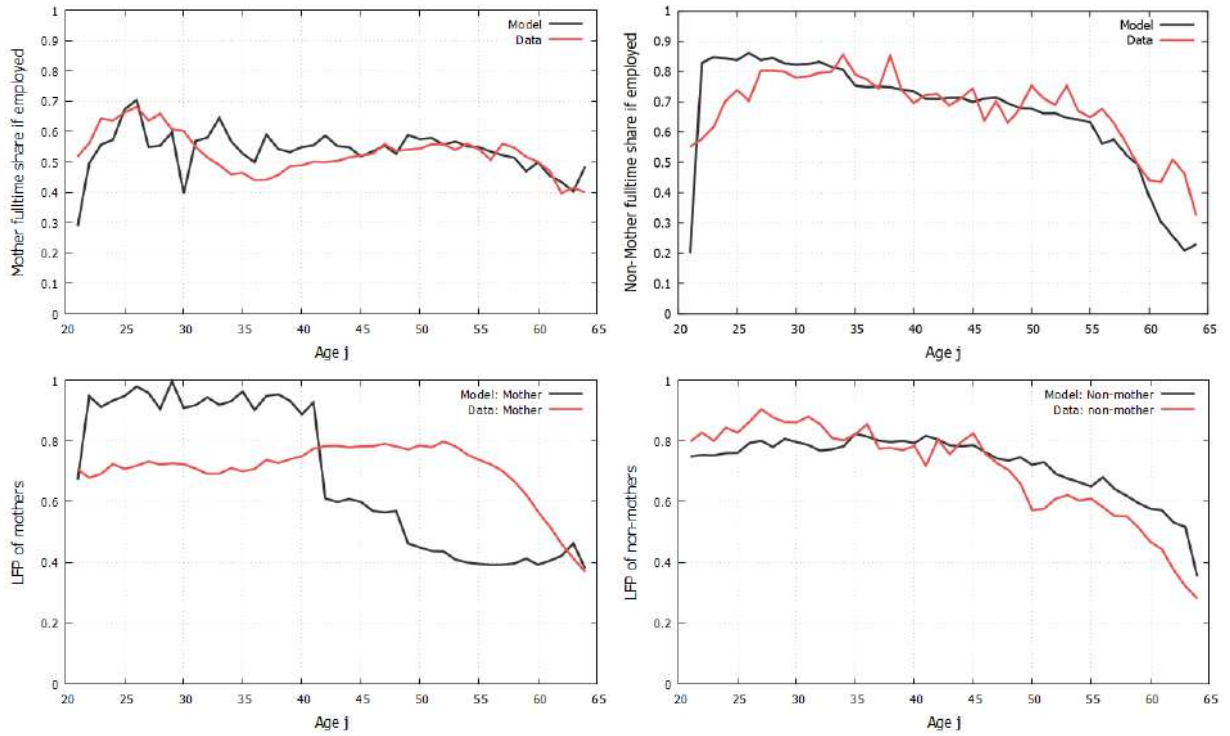


Figure 10: **Model vs Data: Life-cycle profiles of labor supply of women: Top-left**—Full-time share of mothers (targeted); **Top-right**—Full-time share of non-mothers (targeted); **Bottom-left**—Labor force participation of mothers (non-targeted); **Bottom-right**—Labor force participation of non-mothers (non-targeted).

effects encourage parent households to increase their leisure, leading to the decline in participation among mothers in the model.

Several additional assumptions likely contribute to this discrepancy: (i) credit constraints, (ii) absence of non-partner family insurance, (iii) lack of informal care, (iv) perfectly flexible work hour arrangements, and (v) absence of job search frictions or switching costs between part-time and full-time jobs.

Assumptions (i)-(iii) prevent access to alternative forms of insurance during child-rearing years, especially single mothers. This in turn increases the need for self-insurance via labor supply, amplifying deviations from observed behavior. Assumptions (iv) and (v) permit costless adjustments in employment types, which helps explain the immediate change in participation decisions that may not align with real-world dynamics.

To address these limitations, future iterations of the model should relax these assumptions to better reflect real-world constraints and frictions. In addition, incorporating a richer income process could improve the model's capacity to replicate observed patterns beyond first-order data moments.

6 Quantitative analysis

In this section, I analyze the interaction between progressive tax and means-tested child benefit systems, and propose an joint optimal design, where optimality is defined in terms of the overall welfare of newborns under the veil of ignorance (ex-ante welfare). Additionally, I evaluate the impacts of each counterfactual reform on key macroeconomic variables—such as female labor supply, consumption, and output—and the distribution of welfare changes across demographic groups.⁴⁹

In all experiments, discrepancies between the government's consolidated tax revenues and expenditures are resolved by adjusting the overall size (burden) of the tax system through the tax scale parameter ζ_t , ensuring the government budget equation (45) is balanced at time t according to the following rule:⁵⁰

$$\zeta_t = \frac{w_t L_t + (B_{t+1} - B_t) + T_t^C + T_t^K - (G_t + Tr_t + \mathcal{P}_t + r_t B_t)}{\sum_j \sum_{\Lambda \times \Theta} \int_{A \times H \times S^2} \left(\mathbf{1}_{\{\lambda \neq 4\}} \tilde{y}_j^{m^{1-\tau}} + \mathbf{1}_{\{\lambda \neq 3\}} \tilde{y}_j^{f^{1-\tau}} \right) \mu_{j,t} d\Phi_t(z_j)} \quad (78)$$

where \tilde{y}_j^i is the taxable income for $i \in \{m, f\}$, as defined in Subsection 4.5.1.

Table 5 summarizes the overall welfare outcomes of various counterfactual experiments. The results show that while most policy reconfigurations bring about welfare losses relative to the status quo, there are three promising reforms:

1. **Optimal tax reform:** This reform retains the benchmark means-tested child benefits while adjusting tax progressivity. The optimal tax policy is characterized by the progressivity parameter τ^* that maximizes overall (ex-ante) welfare;
2. **Optimal child benefit reform:** This reform introduces a partial universalization of the means-tested child benefit system while maintaining the status quo tax progressivity ($\tau = 0.2$) and the existing structure of the Child Care Subsidy (CCS) program. In particular, the reform replaces means-tested lump-sum benefits (FTB) with a universal lump-sum benefit (per child), referred to as '*Universal Lump-Sum Child Benefits*' or '*Universal FTB*.' The optimal policy in this case is defined as the universal payment rate \bar{r}^* that maximizes overall welfare.
3. **Joint optimal tax and child benefit reform:** This reform integrates the features of the previous two reforms. The joint optimal policy consists of a welfare-maximizing pair of tax progressivity and universal

⁴⁹Following Subsection 4.10, welfare changes are decomposed into six components. Consumption effects consist of allocative efficiency (CEV_{CE}), distributional or equity (CEV_{CD}), and insurance (CEV_{CI}). Similarly, leisure effects contain allocative efficiency (CEV_{LE}), distributional or equity (CEV_{LD}), and insurance (CEV_{LI}).

⁵⁰ ζ_t affects the overall tax burden across all income levels, while holding the tax progressivity τ constant, as explained in Subsection 4.5.1.

lump-sum child benefit rate, $\{\tau^*, \bar{tr}^*\}$. As in the previous case, the structure of the CCS program remains unchanged.

τ	$+(a)$					
No CCS	—	—				
No FTB	—	—	—			
No FTB and CCS	—	NA	NA	—		
No means-testing	—	—	—	NA	—	
Universal FTB	$+(c)$	—	—	NA	NA	$+(b)$
	τ	No CCS	No FTB	No FTB and CCS	No means-testing	Universal FTB

Table 5: Summary of overall welfare outcomes across selected reforms.

Notes: Experiment (a) involves testing different levels of tax progressivity under the existing means-tested child benefits. Experiments (b) and (c) both universalizes the lump-sum child benefit (FTB) system, while keeping the CCS structure at the status quo. The difference is that (b) holds τ fixed at the baseline value 0.2 and optimizes by adjusting the universal lump-sum child benefit payment rate \bar{tr} , whereas (c) jointly optimizes over both τ and \bar{tr} .

In summary, there are two key policy levers: (i) the progressive parameter (τ), and (ii) the universal lump-sum payment rate per child (\bar{tr}). The CCS parameters are kept unchanged, but the subsidy amount responds endogenously to changes in parents' labor supply. The subsequent subsections delve into the aggregate and distributional impacts of these counterfactual policies.

6.1 Optimal tax progressivity

The earlier study by [Tin and Tran \(2024\)](#) finds that the benchmark means-tested child benefits, under the status quo tax progressivity of $\tau = 0.2$, improve overall welfare but reduce labor supply and output. From an equity standpoint, the scheme is desirable as it redistributes welfare to more vulnerable groups, namely, low-education married parents and single mothers. In this subsection, I extend their analysis to explore a scenario where the government can adjust tax progressivity while maintaining the existing means-tested child benefit system, deepening the understanding of the interaction between tax and child benefit systems. Specifically, I assess whether an optimal tax system can complement the child benefit programs' objective of improving the welfare of vulnerable families with dependent children.

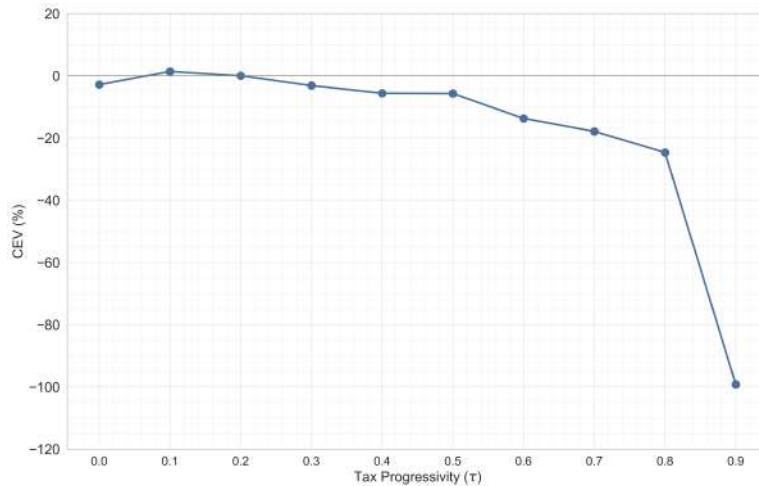


Figure 11: Overall welfare changes over tax progressivity under the benchmark means-tested child benefits.

The optimal tax progressivity (τ^*) is obtained by searching over the parameter space of τ , discretized into 10 evenly spaced grid points ranging from $\tau = 0$ to $\tau = 0.9$.⁵¹ Figure 11 shows the overall (ex-ante)

⁵¹This discretization is for computational feasibility and allows for comparability with the joint optimization exercise in Subsection 6.3, which involves a two-dimensional parameter space of τ and \bar{tr} , discretized into a 10×20 grid.

welfare changes, relative to the status quo, across different levels of tax progressivity. The results indicate that the optimal tax policy sets progressivity at $\tau^* = 0.1$, lower than the baseline level of $\tau = 0.2$. This reform translates into reduced marginal tax rates (MTRs) for higher income brackets and increased MTRs for lower income brackets. For instance, Figure (12) shows that the MTR declines from approximately 28% to 19% for average income earners, and from 38% to 25% for those with twice the average income. Conversely, the zero-tax income bracket shrinks and the MTRs for lower-income households increase.

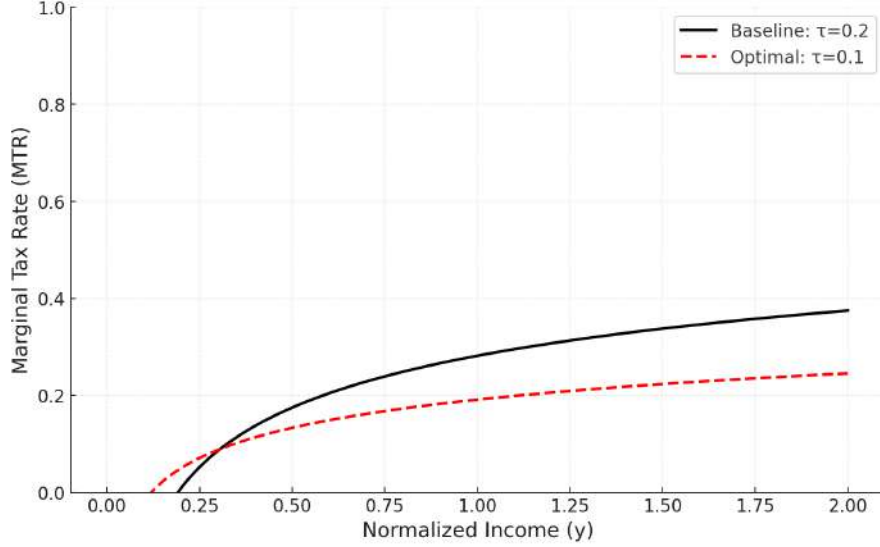


Figure 12: Marginal tax rate (MTR) schedules: baseline ($\tau = 0.2$) vs optimal ($\tau^* = 0.1$).

As detailed in Table 6, the optimal progressivity leads to a 1.38% improvement in overall welfare. The new regime also produces several notable aggregate changes. First, it creates mixed effects on female labor supply: women work 5.71% longer hours but reduce their participation by 2.77 percentage points (*pp*). Second, the overall tax burden (determined by the tax scale parameter ζ) remains virtually unchanged, implying that the 4.85*pp* increase in the average tax rate mainly stems from two factors: (i) the shrinking zero-tax income zone, resulting in more low-income households paying taxes, and (ii) an increase in work hours among women, pushing more of them into higher tax brackets. Finally, despite a 0.5% fall in output, consumption increases modestly by 0.5%.

These aggregate changes suggest two crucial points: (i) a trade-off exists between intensive and extensive margins of labor supply due to the adjustment in tax progressivity, and (ii) increased consumption appears to be the driver of the overall welfare improvement. The following discussion delves deeper into these outcomes.

<i>Optimal tax progressivity</i>			
CCS size, %	+7.14	Fe. Hours, %	+5.71
FTB size, %	0	Fe. Human cap. (H), %	+0.77
Average tax rate, <i>pp</i>	+4.85	Consumption (C), %	+0.50
Tax scale (ζ)	+0.007	Output (Y), %	-0.50
Fe. Lab. Force Part. (LFP), <i>pp</i>	-2.77	Welfare (CEV), %	+1.38

Table 6: Aggregate effects of the optimal tax progressivity reform ($\tau^* = 0.1$) under the benchmark means-tested child benefits.

Notes: Results are reported as changes relative to the levels in the benchmark economy.

Intensive-extensive labor supply trade-off. Figure 13 illustrates that the trade-off between the intensive and extensive margins of labor supply is evident across all demographic groups. Given the negligible change in the scale parameter ζ (+0.007), these female labor supply responses do not arise from shifts in the overall tax burden. Instead, the primary mechanism influencing women's decisions is the change in tax pro-

gressivity. A more proportional system reduces tax liabilities and distortions for higher income earners while increasing them for lower-income earners (Figure (12)). Consequently, this tax structure incentivizes longer work hours but discourages labor force participation, especially among low-education women whose earning capacity confines their income to lower tax brackets, even as they work longer hours.

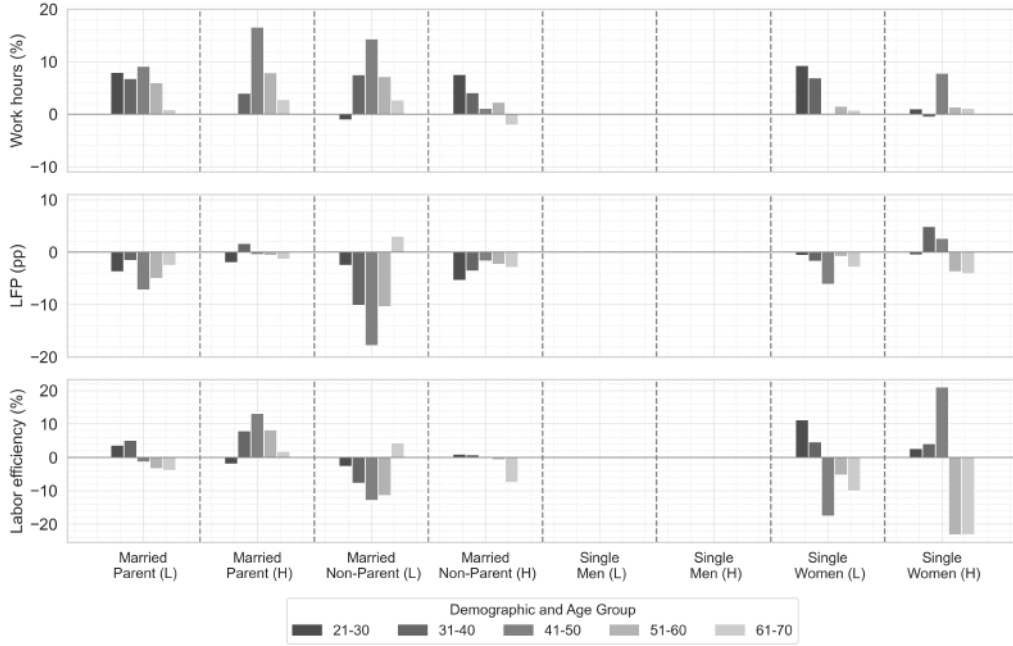


Figure 13: **Female labor supply responses to the optimal tax progressivity under the benchmark child benefits by age and demographic.** (Top: Work hours, Middle: Labor force participation, Bottom: Labor in efficiency units). Notes: As detailed in Subsection 4.1, all single men households are childless, and all single women households are single mothers. The figure illustrates labor supply responses by demographic type, focusing on women in each group. For instance, the “Married Parent (L)” column depicts changes in average work hours, labor force participation, and labor efficiency for women in married parent households.

Sources of welfare changes. Consistent with the aggregate findings in Table 6, the welfare decomposition in Figure 14 indicates that the main channel through which welfare improvements manifest is the increase in consumption allocative efficiency (CEV_{CE}).⁵² Leisure-related welfare effects are relatively minor, partly due to the trade-off between work hours and participation.⁵³

Distributional impacts. The optimal tax regime redistributes welfare to a subset of parents, particularly low-education single mothers and high-education married parents, at the expense of the majority, including low-education married parents (Figure 15). Furthermore, the overall welfare improvement is driven primarily by the significant positive welfare effect for low-education single mothers, which outweighs the smaller combined losses experienced by the rest of the population (excluding high-education married parents).

Low-education single mothers benefit substantially in terms of consumption allocative efficiency. Figure 13 shows that, under the new optimal tax regime, this group significantly increases their work hours during the first 20 years of life, with minimal change in labor force participation. This additional labor effort allows them to boost their consumption by almost 10% during younger years (Figure 16), despite a subsequent decline between ages 40 and 70. Their improved consumption allocative efficiency implies that, in the initial steady state, young low-education single mothers had higher marginal utilities of consumption relative to their older selves. Several factors contribute to this outcome.⁵⁴ For instance, early parenthood imposes penalties on

⁵²See Subsection 4.10 for formal definitions of CEV and its components.

⁵³Notably, lowering tax progressivity also has only minor effects on the distributional and insurance components of consumption. In Subsection 6.1.1, I demonstrate that this result is not unique to the case of tax progressivity reform. Additional analysis in Appendix Subsection F.2 further reveals that access to the CCS, which enhances parents’ self-insurance capacity, helps cushion the impacts of other policy reforms on the distributional and insurance components of welfare.

⁵⁴In the benchmark model, 62.5% of single mothers are hand-to-mouth at age 21. Low-education single mothers have, on average, 10% lower consumption than their high-education peers and less than one-third of what married households consume.

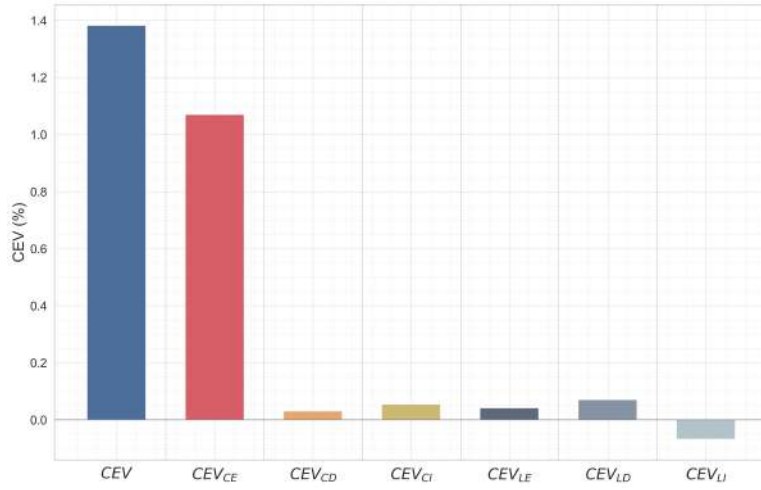


Figure 14: **Decomposition of welfare changes under the optimal tax progressivity ($\tau^* = 0.1$) and benchmark means-tested child benefits.**

their household consumption and introduces child-related costs for working during younger years when human capital and wealth stocks are limited. Additionally, the absence of spousal earnings and the no-borrowing constraint heighten their reliance on labor supply. As a result, the reduction in tax progressivity allows them to work and earn more during critical parenting years, easing their self-insurance constraints and improving their consumption allocative efficiency.

For the losers of this reform, welfare losses also stem from changes in consumption allocative efficiency. Figure 16 reveals a common pattern: these households reduce early-life consumption in favor of accumulating more wealth to subsidize later-life consumption. Although the new tax scheme may help mitigate means-testing distortions at higher income levels, it makes low-income employment more costly, prompting households to save more for consumption smoothing purpose. This pattern of behavioral changes is especially pronounced for high-education single mothers, who lack family insurance, and for low-education married households, whose limited earning potential restricts them to the low-income bracket. Ultimately, these adjustments result in less allocatively efficient consumption profiles, leading to welfare losses.

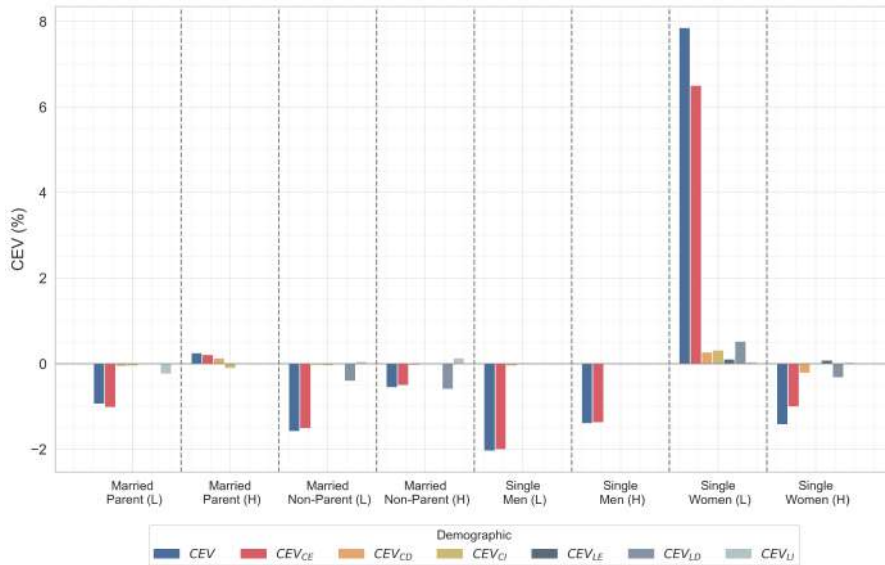


Figure 15: **Distribution of welfare changes under the optimal tax progressivity ($\tau^* = 0.1$) and benchmark means-tested child benefits.**

Notes: As detailed in Subsection 4.1, all single men households are childless, and all single women households are single mothers.

In general, this policy experiment reveals two main insights. First, the interaction between taxes and child benefits matters. Given the existing means-tested child benefits in Australia, the optimal tax system features lower progressivity, which enables low-education single mothers to increase work hours, earnings, and consumption during the critical years of parenthood. Therefore, if reforming child benefits is not feasible, adjusting the tax system may serve as an indirect route to improve overall welfare and support some of the vulnerable groups.

Second, an isolated tax reform has limitations. By redistributing along the income dimension alone and neglecting parents' unique constraints, it risks undermining the objectives of the child benefit system. With optimal progressivity, the majority of the population, including low-education married parents, are made worse off. Reduced tax progressivity increases the costs of low-income employment for young and low-education households, leading to greater reliance on savings as a self-insurance vehicle in lieu of work. This reduces their allocative efficiency in consumption, resulting in welfare losses of up to 2%. Since the losers constitute a larger share of the population, this reform is unlikely to garner majority support.

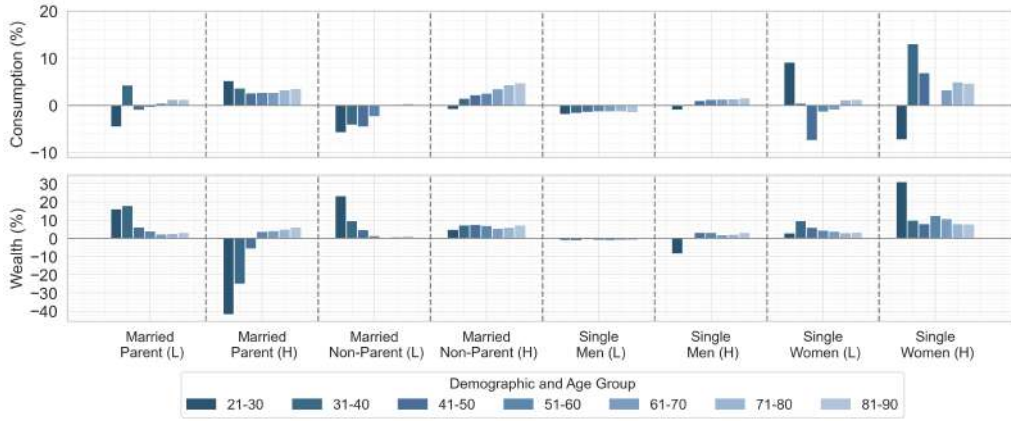


Figure 16: **Household consumption and wealth responses to the optimal tax progressivity reform by age and demographic (Top: Consumption, Bottom: Wealth).**

Notes: As detailed in Subsection 4.1, all single men households are childless, and all single women households are single mothers.

6.1.1 Deviations from optimal progressivity

To further explore the interaction between tax and child benefit systems, I extend the analysis to examine the aggregate and distributional implications of two tax scenarios that deviate from the optimal value: a proportional system ($\tau = 0$) and a highly progressive system ($\tau = 0.6$). The aggregate results in Table 7 indicate that both systems lead to overall welfare losses.

Under the proportional system, the flattening of the ATR and MTR schedules, as illustrated in Figure 17, shifts greater tax burdens and distortions from high- to low-income brackets (relative to the optimal tax system) and exacerbates the intensive-extensive labor supply trade-off. Although female workers increase their hours by 8% and accumulate +0.97% higher human capital, female labor force participation, consumption, and output decrease by 4.62pp, 0.39%, and 0.46%, respectively. Ultimately, overall welfare declines by 2.86%.

In contrast, a highly progressive system ($\tau = 0.6$) heightens tax burdens for high-income brackets. This produces the opposite effects, leading to a 7.29% reduction in female work hours, while participation increases by 9.8pp. Moreover, this regime introduces a new adverse force on households by increasing the overall tax burden in the economy, reflected by the 0.14 points reduction of the tax scale parameter (ζ) to balance the government budget. As evident in Figure 17, the average tax rates (ATRs) increase by over 10pp and the zero-tax income zone contracts. Even with the expanded female workforce (tax base), the combination of higher tax progressivity and lower average work hours intensifies fiscal pressure, causing the ATRs to rise by 12.37%. Consumption and output shrink by 2.21% and 2.16%, respectively, culminating in a substantial welfare loss of

<i>Deviations from optimal tax progressivity</i>			
	$\tau = 0$	$\tau^* = 0.1$	$\tau = 0.6$
CCS size, %	+7.14	+7.14	+14.29
FTB size, %	−5.55	0	−11.11
Average tax rate, pp	+3.66	+4.85	+12.37
Tax scale (ζ)	+0.014	+0.007	−0.14
Fe. LFP, pp	−4.62	−2.77	+9.80
Fe. Hour, %	+7.99	+5.71	−7.29
Fe. H. cap, %	+0.97	+0.77	+0.20
Cons (C), %	−0.39	+0.50	−2.21
Output (Y), %	−0.46	−0.50	−2.16
Welfare (CEV), %	−2.86	+1.38	−13.72

Table 7: **Aggregate implications of different levels of tax progressivity:** Proportional ($\tau = 0$), Optimal ($\tau^* = 0.1$), and Highly progressive ($\tau = 0.6$).

Notes: Results are reported as changes relative to the levels in the benchmark economy.

13.72%.⁵⁵

The magnitude of welfare loss increases exponentially as tax progressivity deviates further from the optimal level, driven almost exclusively by declines in consumption allocative efficiency (Appendix Figure 33). Moreover, Figure 34 in the Appendix reveals consistent outcomes in aggregate and distributional terms. When $\tau = 0.6$, the higher MTRs for higher income brackets and the increased overall tax burden significantly worsen consumption allocative efficiency and welfare for all households, parents included. Their losses suggest that the reduced after-tax earnings under a highly progressive tax regime are not adequately compensated by the child benefits they receive.⁵⁶

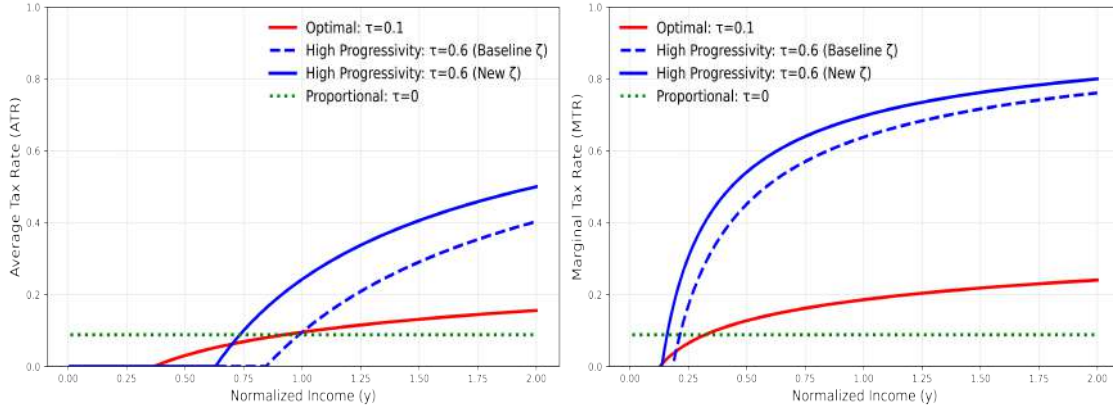


Figure 17: **Average tax rate (left panel) and marginal tax rate (right panel) under four scenarios:** proportional ($\tau = 0$), optimal tax progressivity ($\tau^* = 0.1$), highly progressive system ($\tau = 0.6$) with the baseline tax scale, and highly progressive system ($\tau = 0.6$) with the new (budget-balancing) tax scale.

On the contrary, under a proportional tax regime (Appendix Figure 35), welfare gains are observed only among high-education couples, mainly due to favorable consumption efficiency and leisure distributional (CEV_{LD}) effects over their life cycle.⁵⁷ These gains are however insufficient to offset the losses incurred by other demographics, resulting in overall welfare loss of 2.86% for newborn households. Nonetheless, compared to scenarios with higher tax progressivity (Appendix Figure 33), the welfare impact is less severe. Additionally, the loss under this regime stems from diverse factors, including negative consumption distributional (CEV_{CD})

⁵⁵Additional factors, such as the CCS program's expansion and reduced consumption tax revenue due to lower aggregate consumption, further increase the demand for income tax revenue.

⁵⁶Based on Figure 46, most households experience sustained declines in consumption over the life cycle, with the exception of working-age single mothers whose consumption falls only in later stages of life.

⁵⁷A higher leisure distributional effect implies that these households can expect to enjoy above-average leisure relative to the population under the new tax policy.

and leisure efficiency (CEV_{LE}) effects, although consumption allocative efficiency remains the primary driver. For most demographics, including low-education parents, the increased cost of low-income work under the proportional system prompts some to exit the labor force while others extend their work hours. The net result is a deterioration in the allocative efficiency of both consumption and leisure, leading to welfare losses. The exception is low-education single mothers, who see some improvements in consumption allocative efficiency (for reasons discussed in Subsection 6.1). However, the larger reductions in their leisure allocative efficiency (CEV_{LE}) and consumption distributional (CEV_{CD}) effects—reducing their expected consumption relative to the population average—result in a net welfare loss for this group. Hence, excessively low tax progressivity benefits few households while potentially harming vulnerable demographics. That is, despite the provision of child benefits, labor supply remains an essential self-insurance mechanism for parents. The effects of tax reforms on the labor earnings of various parental groups should be carefully considered.

In summary, the findings here offer additional policy lessons, complementing insights from earlier results. First, the impacts of tax progressivity reforms are asymmetric. As demonstrated, reducing tax progressivity has a minimal impact on the overall tax burden, which helps limit its adverse welfare effect. In contrast, increasing progressivity creates fiscal stress that elevates the overall tax burden and amplifies welfare losses. Second, an optimal tax design must account for fiscal sustainability. While a proportional tax regime primarily benefits high-education married parents at the expense of low-education households, excessive progressivity is counterproductive, harming everyone and benefiting no one.

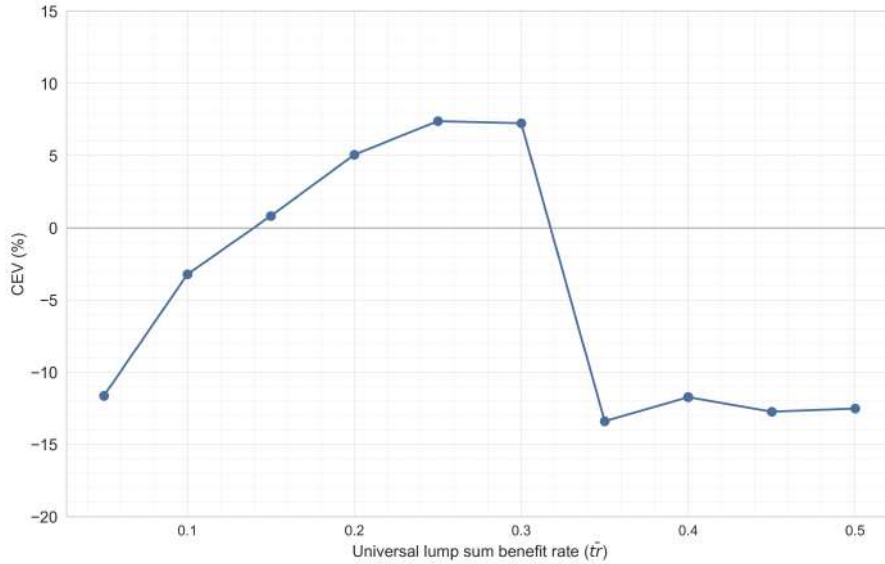


Figure 18: Overall welfare changes over different payment levels of universal lump-sum child benefits per child ($\bar{tr} \times \text{average income in 2018}$) under the benchmark tax progressivity ($\tau = 0.2$).

6.2 Optimal child benefits

The optimal tax system moderately increases (ex-ante) overall welfare but proves detrimental to many low-education households, including some parents, by placing greater tax liabilities and distortions on low-income brackets, which reduce their consumption allocative efficiency and welfare.

In light of these findings, I explore an alternative reform referred to as *Universal Lump-Sum Child Benefits* or *Universal FTB*. This policy partially universalizes the child benefit system by removing means-testing and demographic criteria from the FTB program to provide uniform lump-sum transfers (per child) to all parents. Meanwhile, the status quo means-tested CCS policy parameters are kept unchanged, though subsidies can still adjust endogenously in response to changes in female labor supply, thus having fiscal impacts.

The optimal child benefit policy is a universal child benefit payment rate (\bar{tr}^*) that maximizes overall

Aggregate implications of universal child benefits (per child)			
	$\bar{tr} = 15\%$	$\bar{tr}^* = 25\%$	$\bar{tr} = 35\%$
CCS size, %	0	0	+14.29
FTB size, %	+166.67	+341.67	+519.44
Average tax rate, pp	+5.53	+6.85	+20.59
Tax scale (ζ)	-0.025	-0.050	-0.22
Fe. LFP, pp	-0.09	-1.834	+1.59
Fe. Hour, %	-0.63	-3.48	-3.84
Fe. H. cap, %	-0.32	+0.27	+0.09
Cons (C), %	+0.75	+0.94	-12.29
Output (Y), %	+0.01	-1.26	-15.81
Welfare (CEV), %	+0.82	+7.39	-13.40

Table 8: **Aggregate implications of universal lump-sum child benefits per child at three levels of payment rate (\bar{tr}) as a proportion of average income in 2018:** 15% (first column), 25% (optimal, second column) and 35% (third column). *Notes: Results are reported as changes relative to the levels in the benchmark economy. Average income is approximately AUD 60,000 in 2018 dollars.*

welfare. It is determined by searching over the parameter space of the payment rate that is discretized into 20 evenly spaced grid points ranging from $\bar{tr} = 0.05$ to $\bar{tr} = 1$. I also examine whether this policy can deliver better parental and distributional welfare outcomes compared to the optimal tax reform in Subsection 6.1.

Figure 18 indicates that the optimal universal lump-sum benefit per child (\bar{tr}^*) is 25% of average income in 2018, or approximately AUD 15,000 per annum. As shown in Table 8, this child benefit plan results in a modest 0.94% increase in consumption and a significant 7.39% rise in overall welfare. However, its funding (341.67% increase in FTB spending) leads to a 6.85 pp jump in the average tax rate, and there are macroeconomic costs, such as declines in female labor force participation, work hours, and output of 1.83 pp , 3.48%, and 1.26%, respectively.

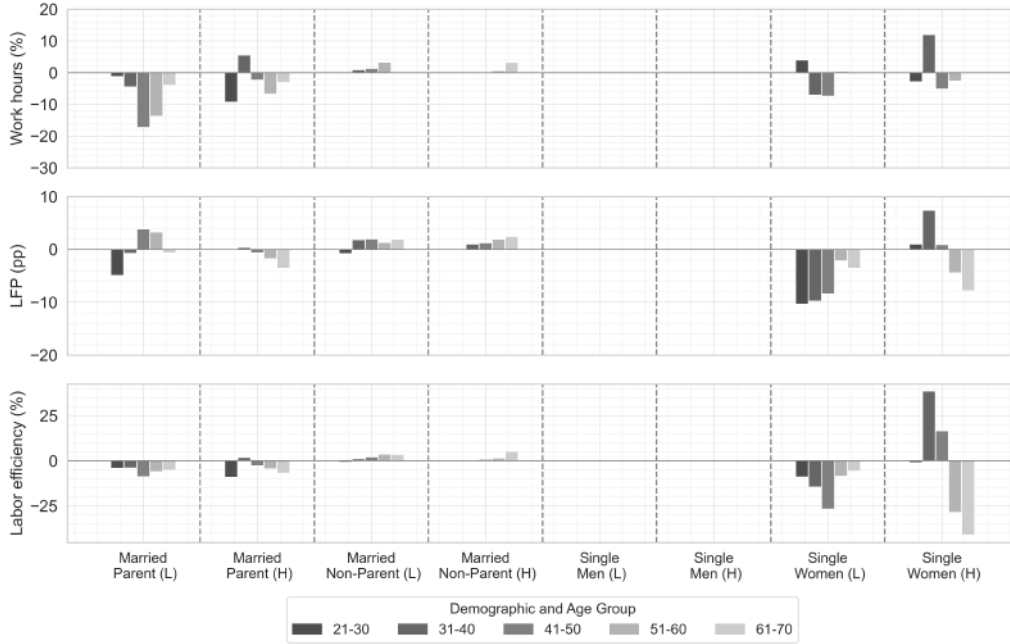


Figure 19: **Female labor supply responses to the optimal child benefit system ($\bar{tr}^* = 25\%$) by age and demographic.** (Top: Work hours, Middle: Labor force participation, Bottom: Labor in efficiency unit). *Notes: As detailed in Subsection 4.1, all single men households are childless, and all single women households are single mothers. The figure illustrates labor supply responses by demographic type, focusing on women in each group. For instance, the “Married Parent (L)” column depicts changes in average work hours, labor force participation, and labor efficiency for women in married parent households.*

Female labor supply and consumption responses. Unlike the tax reform in Subsection 6.1, which leads to an intensive-extensive labor supply trade-off, the optimal child benefit scheme results in declines in both female labor force participation and work hours, particularly among mothers (Figure 19).

For non-parents, the negative wealth effect from the increased tax burden make them exert greater work

effort, but their labor supply changes remain modest, with increases hovering around 2pp for participation and 2% for work hours (Figure 19). At the same time, this group experiences a sustained consumption decline by approximately 4-5% throughout their life cycle. They also save more, with up to 10% increase in wealth near retirement for childless couples (Figure 20), demonstrating a stronger reliance on savings as a means of self-insurance. Single male households exhibit similar changes in their consumption and wealth profiles, though the changes are more pronounced due to the model's restriction on their ability to adjust labor supply.

For parent households, responses vary but generally show significant reductions in labor supply. This reflects the dominance of positive wealth effects from the new universal child benefits, especially among those with low education. For instance, young low-education single mothers reduce their participation by about 10pp during most of their prime working years, leading to labor efficiency losses of up to 25%. However, for low-education parents, Figure 20 indicates that these lost labor earnings are offset by substantial increases in wealth for self-insurance purposes. Ultimately, their average consumption levels increase considerably during younger years, although their reduced work effort causes their consumption to fall later in life after they exit the child benefit programs.

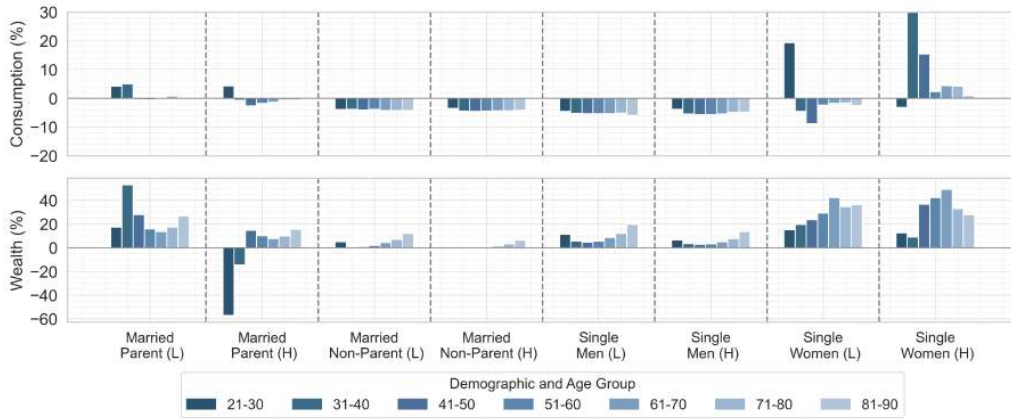


Figure 20: **Household consumption and wealth responses to the optimal child benefit system ($\bar{t}^* = 25\%$) by age and demographic (Top: Consumption, Bottom: Wealth).**

Notes: As detailed in Subsection 4.1, all single men households are childless, and all single women households are single mothers.

An exception is high-education single mothers, whose responses deviate from the norm. They substantially increase their labor supply and consumption between the ages of 31 and 40, coinciding with the arrival of their second child. Their labor response suggests that the combined work incentive effects from the removal of means-testing for the FTB program and the negative wealth effect from higher tax burdens outweigh the disincentive effects of the transfers. This group also experiences significant wealth increases over their life cycle, by as much as 45% between ages 51 and 60 (Figure 20). These wealth gains support their increased leisure after age 50.

Distribution of welfare changes. Figure 20 indicates that the overall welfare gains under the optimal child benefit system are driven exclusively by welfare improvements for parents. The biggest beneficiaries are low-education single mothers, who experience welfare increases of up to 23%, attributable to the significantly larger consumption and leisure during the critical child-rearing period. Additionally, these results imply that, for parents, the universal FTB benefits they receive more than offset the adverse impacts of the increased overall tax burden required to fund the program. Conversely, non-parent households bear the cost of the reform, with a post-reform welfare decline of approximately 4% due to the tax burden.

As opposed to the optimal tax reform, which fails to deliver benefits to all parents, the optimal child benefit regime accomplishes this goal while also providing greater welfare improvements overall and for vulnerable parent households. However, this achievement also entails higher welfare losses for non-parents, raising equity concerns.

Deviations from the optimal benefit payment. Figure 22 indicates that while a less generous transfer

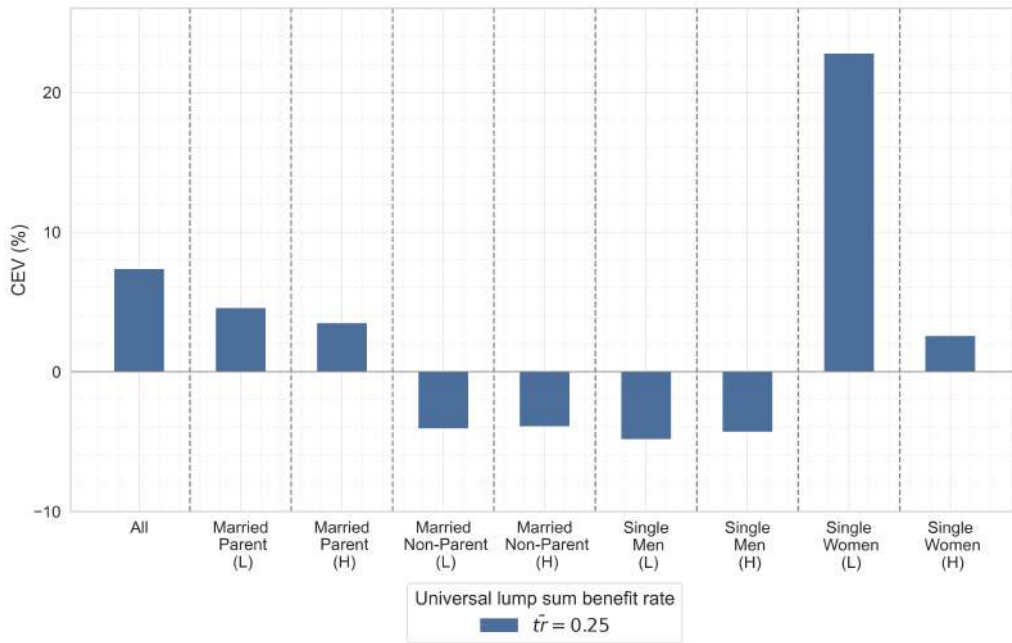


Figure 21: **Distribution of welfare changes under the optimal child benefit system ($\bar{tr}^* = 25\%$).**

Notes: As detailed in Subsection 4.1, all single men households are childless, and all single women households are single mothers.

payment imposes a smaller tax burden and reduces welfare losses for non-parents, it may be insufficient to compensate recipients for their reduced after-tax earnings, resulting in welfare losses for the intended beneficiaries instead. As illustrated, a lower payment rate of $\bar{tr} = 15\%$ brings about an approximately 1% welfare loss for low-education single mothers.

In contrast, expanding the universal FTB program adversely impacts all households, including vulnerable parents. As shown in Table 8, a more generous payment rate of $\bar{tr} = 35\%$ of average income (or AUD 21,000) causes the average tax rate to rise by 20.59pp. The tax scale parameter ζ falls by 0.22 points—over four times the change observed under the optimal child benefit scheme. This substantial tax burden leads to a welfare decline of up to 30% for non-parent households and negates the benefits of short-term transfers for parents, causing an approximate 12% welfare loss for this group.

Composition of welfare changes. As illustrated in Figure 18, overall welfare changes as the child benefit rate \bar{tr} varies exhibit an almost hump-shaped profile. Payments between 15% and 30% result in positive welfare effects, whereas amounts exceeding 30% lead to a sharp welfare decline, reaching approximately -12% . Appendix Figure 36 shows that these welfare outcomes are primarily driven by consumption allocative efficiency. While the leisure insurance effect (CEV_{LI}) is present, it is modest. For instance, under the optimal child benefit system, the 7.39% welfare gain is largely explained by a 5.47% increase in consumption allocative efficiency and a 2.44% rise in leisure insurance (Table 9). There are losses from reduced consumption insurance (CEV_{CI}) and leisure allocative efficiency (CEV_{LE}), but these effects are relatively minor.

Appendix Figure 37 reveals similar mechanisms driving welfare changes across demographic groups. For non-parents, welfare losses are almost entirely attributable to declines in consumption allocative efficiency, with minimal contributions from other factors. For parents, the dominance of consumption allocative efficiency in explaining welfare improvements is evident, aligning with the consumption patterns in Figure 20. Substantial post-reform consumption increases among parent households during child-rearing years—especially for young low-education single mothers—boost allocative efficiency. This occurs despite some decreases in consumption as these households age. The findings suggest that young parent households, on average, have higher marginal utilities of consumption than their older counterparts due to credit constraint and larger household sizes with dependent children.

Low-education single mothers are the only group to see a pronounced increase in leisure insurance, reflecting

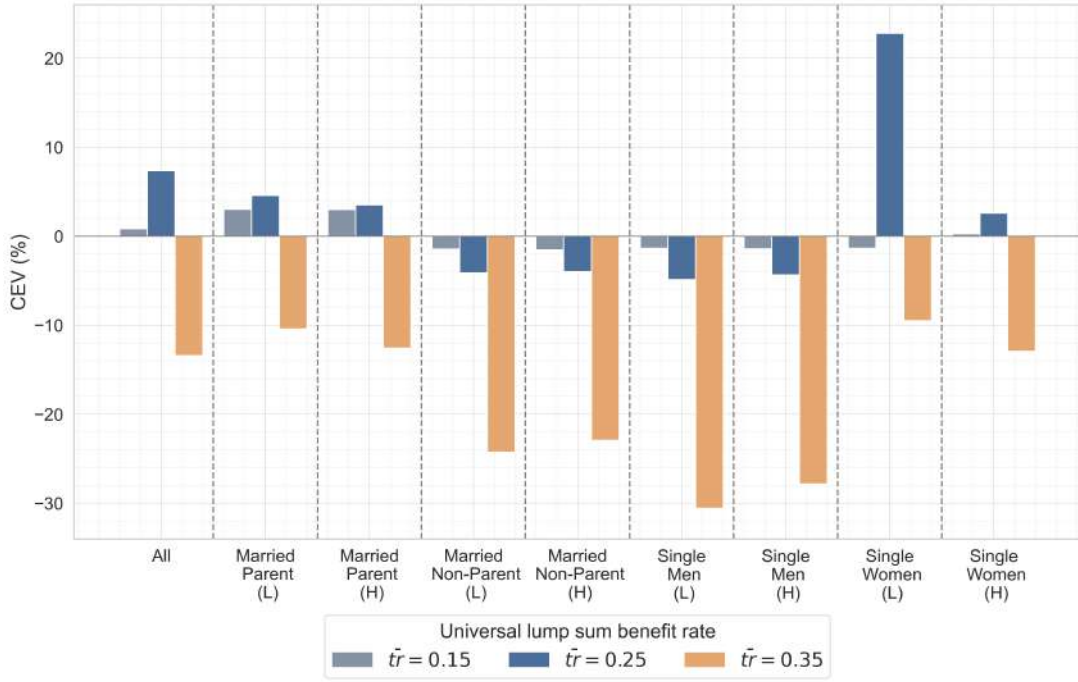


Figure 22: **Distribution of welfare changes over different levels of universal child benefits per child (\bar{tr}).**
Notes: As detailed in Subsection 4.1, all single men households are childless, and all single women households are single mothers.

lower ex-post leisure risk. This stems from higher public support and increased savings (Figure 20) under the optimal child benefit regime, which enable better leisure outcomes in the face of adverse shocks. Indeed, the enhanced leisure insurance for low-education single mothers is a major contributor to the average improvement in the leisure insurance effect observed in Table 9.

Welfare (%)	CEV	CEV_{CE}	CEV_{CD}	CEV_{CI}	CEV_{LE}	CEV_{LD}	CEV_{LI}
$\bar{tr}^* = 25\%$	+7.39	+5.47	+0.046	-0.32	-0.76	+0.13	+2.44

Table 9: **Decomposition of overall welfare changes under the optimal child benefit reform ($\bar{tr}^* = 25\%$).**

These results offer three key lessons. First, the optimal child benefit reform generates a significantly stronger welfare effect—nearly an order of magnitude larger—compared to the optimal tax regime in Subsection 6.1. Second, the reform is highly advantageous for vulnerable parents, particularly low-education single mothers, by enabling more efficient allocation of consumption over their life cycle and improving ex-post leisure outcomes. However, it also results in notable reductions in labor supply and human capital for this group. Third, the optimal child benefit system redistributes welfare from non-parents to parents. Overly generous child benefits fail to offset the adverse effects of the accompanying tax burden, leading to welfare losses for all households, including the intended beneficiaries. In contrast, a less generous payment, while alleviating the tax burden on non-parents, risks providing inadequate support for parents.

6.3 Optimal taxes and child benefits

The standalone tax and child benefit reforms exhibit distinct quantitative and qualitative impacts. In this section, I explore their joint design to assess whether combining both systems can yield further aggregate and/or distributional improvements. This analysis focuses on a counterfactual reform that jointly optimizes tax progressivity (τ) and the payment rate (\bar{tr}) of the *Universal Lump-Sum Child Benefit program* (*Universal FTB*), while deferring the exploration of a broader set of means-testing parameters—such as phase-out rates and income-test thresholds—for future work. Specifically, I search for an optimal policy mix—a pair $\{\tau^*, \bar{tr}^*\}$ that

maximizes ex-ante welfare—over a two-dimensional discretized parameter grid for τ and \bar{tr} . The space consists of 200 parameter pairs, formed by the Cartesian product of the discretized sets for τ ($\{0, 0.1, \dots, 0.9\}$) and \bar{tr} ($\{0.05, 0.1, \dots, 1\}$). I also examine outcomes related to parental welfare, distribution, and key macroeconomic variables, such as female labor supply and output.

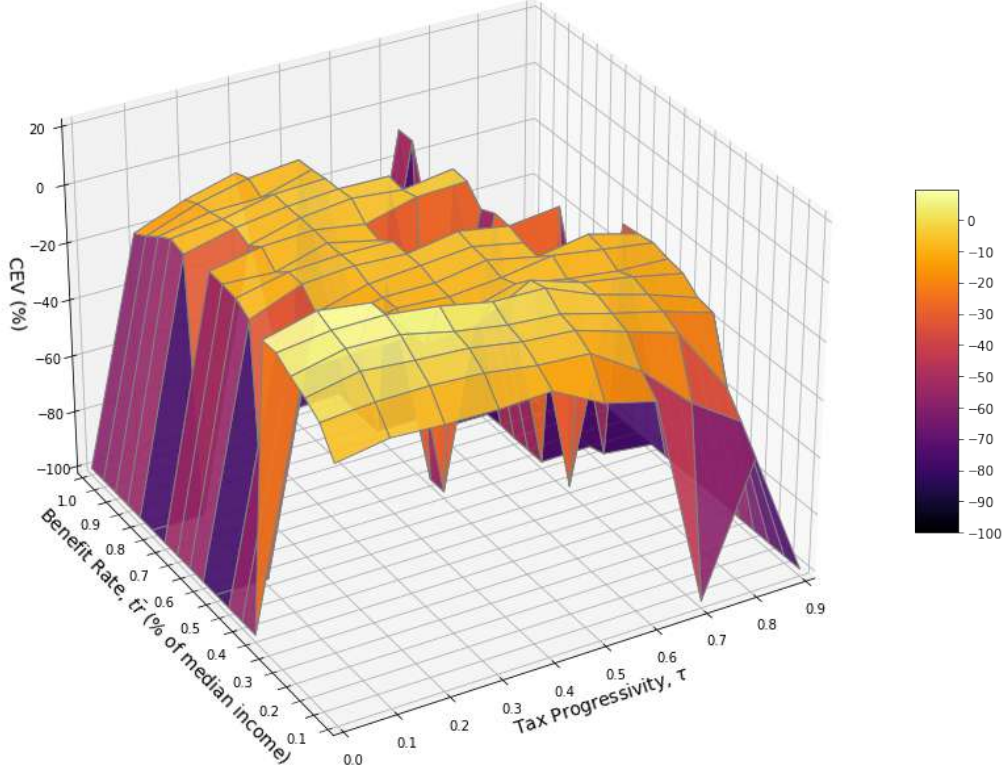


Figure 23: Overall welfare changes over different combinations of tax progressivity (τ) and universal lump-sum child benefit rate per child (\bar{tr}).

Notes: For a cross-sectional view at $\tau^* = 0.1$, refer to Appendix Figure 38.

6.3.1 Optimal tax progressivity and universal lump-sum child benefits

As shown in Figure 23 and Appendix Figure 38, the joint optimal design of taxes and child benefits calls for a tax progressivity of $\tau^* = 0.1$ and a universal lump-sum benefit per child of $\bar{tr}^* = 30\%$ of average income, approximately AUD 18,000 in 2018. Under this system, a household with two children—regardless of income, marital status, or children’s ages—would receive \$36,000 annually. These closely resemble the optimal policies identified in the previous individual reforms, with a slightly more generous transfer rate that is 5 percentage points (*pp*) higher than the rate under the standalone optimal child benefit regime in Subsection 6.2. This amount is over 1.5 times the maximum benefit and nearly three times the average benefit per child provided under the baseline FTB program.⁵⁸

⁵⁸The means-tested FTB program comprises two components: FTB Part A (FTB-A) and FTB Part B (FTB-B), both conditional on marital status and the age of children. FTB-A is a per-child transfer, while FTB-B is a per-family payment designed to support low-income single or single-earner families. FTB-A provides a maximum of AUD 7,000 per child, and FTB-B delivers up to AUD 4,500 per family. Combined benefits grow non-linearly with the number of children. For one-child families, the proposed optimal policy is 1.5 times higher than the maximum transfer amount. For two-child families, the total benefits under the status quo can reach up to AUD 18,500 annually, although the amount is contingent on the children’s ages. For instance, FTB-B’s maximum benefit is reduced by AUD 1,000 if all children in the family are older than five years. On average, the FTB program delivers AUD 12,000 per family. With the average number of dependent children in Australia around 1.8 per family—comparable to the 2018 fertility rate—the average benefit per child under the FTB system is approximately AUD 6,700. Thus, the proposed universal transfer is 2.7 times higher than the current average benefit per child.

At the aggregate level, Table 10 indicates that the jointly optimized tax and child benefit system increases consumption by 1.37% and overall welfare by 9.64%. However, the dramatic 430.56% increase in universal FTB spending exerts significant pressure on the tax system, causing the tax scale parameter ζ to decrease by 0.029 and the average tax rate to rise by 6.57%. Tax burdens increase across income levels, including for lower-income workers. This contributes to significant declines in female labor force participation, work hours, and output by 5.04pp, 5.23%, and 1.06%, respectively.

<i>Aggregate implications of optimal tax and universal child benefits</i>			
	$\bar{t}r = 20\%$	$\bar{t}r^* = 30\%$	$\bar{t}r = 40\%$
CCS size, %	-3.06	-28.43	-8.49
FTB size, %	+252.78	+430.56	+608.33
Average tax rate, pp	+4.94	+6.57	+22.36
Tax scale (ζ)	-0.004	-0.029	-0.212
Fe. LFP, pp	-4.87	-5.04	-2.35
Fe. Hour, %	+0.92	-5.23	-5.43
Fe. H. cap, %	-0.45	-0.35	-0.86
Cons (C), %	+1.39	+1.37	-12.57
Output (Y), %	+0.44	-1.06	-16.38
Welfare (CEV), %	+5.57	+9.64	-14.89

Table 10: **Aggregate implications of joint optimal tax ($\tau^* = 0.1$) and child benefit system at at three levels of universal lump-sum payment:** 20% (first column), 30% (second column) and 40% (third column) of average income in 2018. *Notes: Results are reported as changes relative to the levels in the benchmark economy. Average income is approximately AUD 60,000 in 2018 dollars.*

Tax consequences. The right panel of Figure 24 demonstrates that, under the joint optimal system, the marginal tax rate (MTR) schedule (the solid red line) is generally lower than that of the optimal child benefit system (the green dashed-dotted line) due to reduced tax progressivity. This implies a greater work disincentive effect under the standalone child benefit reform, affecting most households, including low-income earners.

However, the average tax rate (ATR) schedule under the joint optimal system imposes the highest tax burdens on low-income earners (left panel of Figure 24). Moreover, despite sharing the same level of tax progressivity ($\tau^* = 0.1$) as the optimal tax reform in Subsection 6.1, the joint reform necessitates additional revenue to fund the universal child benefit program. As a result, the tax schedule shifts upward (from the dashed blue to the solid red line), narrowing the zero-tax income zone and raising ATRs across the income spectrum.

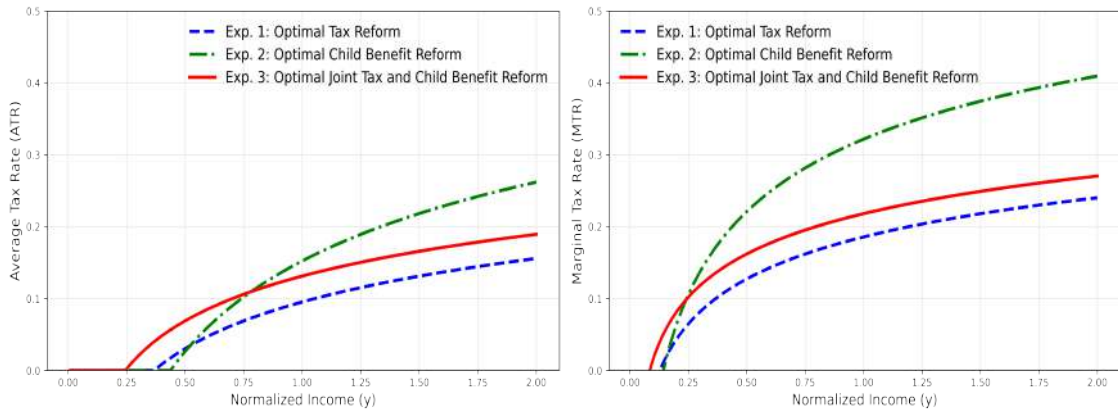


Figure 24: Average tax rate (**left panel**) and marginal tax rate (**right panel**) across the three counterfactual experiments: optimal tax reform ($\tau^* = 0.1$, benchmark means-tested child benefit system), optimal child benefit reform (benchmark tax progressivity $\tau = 0.2$, $\bar{t}r^* = 25\%$), and optimal joint tax and child benefit reform ($\tau^* = 0.1$, $\bar{t}r^* = 30\%$).

Compared to the optimal child benefit reform in Subsection 6.2, the joint optimal design shifts a greater share of transfer program funding to lower-income households due to its lower tax progressivity. For example, individuals earning 35 of the average income pay no taxes under either the optimal tax or child benefit reforms

but face a 5% average tax rate under the joint system.

Household responses under the optimal tax and child benefit system. Figure 25 provides insights into labor supply and consumption responses. For non-parent couples, who do not receive child benefits, their decisions are influenced solely by the tax consequences. The less progressive tax structure shifts tax liabilities from higher- to lower-income brackets, encouraging longer work hours but reducing participation, especially among low-education childless women. Furthermore, Figures 26 and 57 illustrate a noticeable adverse impact of the tax burden on non-parents' consumption, particularly during their younger years, with declines of up to 8%.

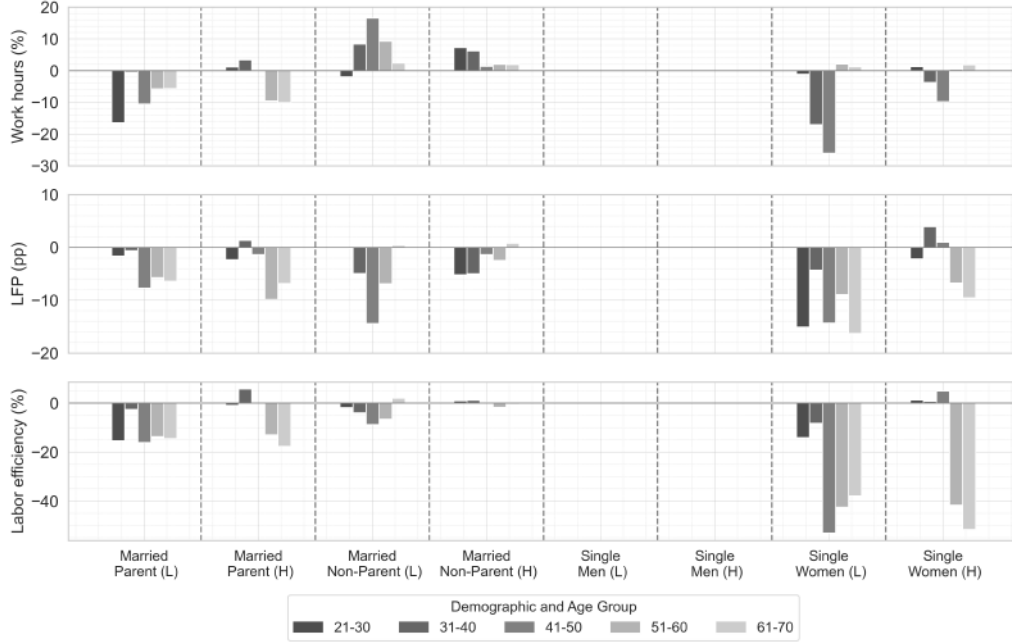


Figure 25: **Female labor supply responses to the optimal tax and child benefit system by age and demographic.** (Top: Work hours, Middle: Labor force participation, Bottom: Labor in efficiency unit).

Notes: As detailed in Subsection 4.1, all single men households are childless, and all single women households are single mothers. The figure illustrates labor supply responses by demographic type, focusing on women in each group. For instance, the “Married Parent (L)” column depicts changes in average work hours, labor force participation, and labor efficiency for women in married parent households.

For parent households, their labor supply profiles in Figure 25 reveal that the joint optimal system leads to a significant drop in female labor supply. Although parents and non-parents face the same tax schedule, the universal lump-sum benefit scheme provides financial support that diminishes mothers' incentives to work. This positive wealth effect is especially pronounced among low-education single mothers, whose work hours and participation decline by up to 25% and 15pp, respectively, during their prime working years. Figure 26 suggests that the decreased labor supply is also influenced by parents' enhanced ability to accumulate wealth from the universal benefits, allowing them to self-insure against future risks without relying as heavily on labor income. Consequently, parents, particularly young single mothers, see substantial improvements in their consumption and leisure profiles under the joint optimal tax and child benefit reform.

Distribution of welfare changes. Gains in average consumption and leisure over the life cycle for parents, contrasted with declines for non-parents, help explain the distribution of welfare changes under the new regime. As depicted in Figure 27, all parent households enjoy substantial welfare improvements, with low-education single mothers seeing the largest increase of up to 27%. High-education married parents, while receiving the smallest gains among the recipients, still benefit from a 4.6% welfare boost. Given that parents constitute 77% of the model population, the reform would likely garner majority support.

However, the joint optimal system constitutes a redistribution from non-parents, who are non-beneficiaries of the universal child benefit program, to parents, who are direct recipients. While parental and overall welfare

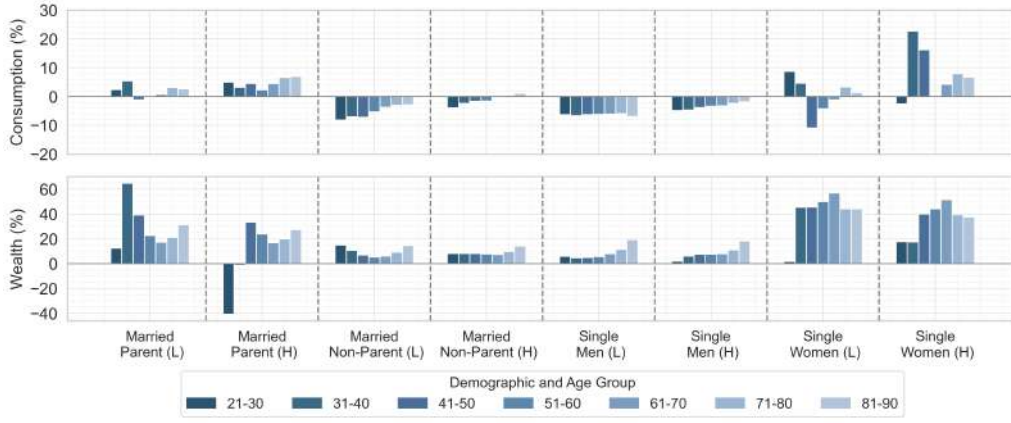


Figure 26: **Household consumption and wealth responses to the optimal tax and child benefit system by age and demographic.** (Top: Consumption, Bottom: Wealth).

Notes: As detailed in Subsection 4.1, all single men households are childless, and all single women households are single mothers.

see significant gains, non-parent households experience substantial losses. Their welfare declines by 4-7% (Table 11), approximately 2pp higher than their losses under the optimal child benefit system in Subsection 6.2 due to the higher tax burden, particularly on lower-income earners (left panel of Figure 24).

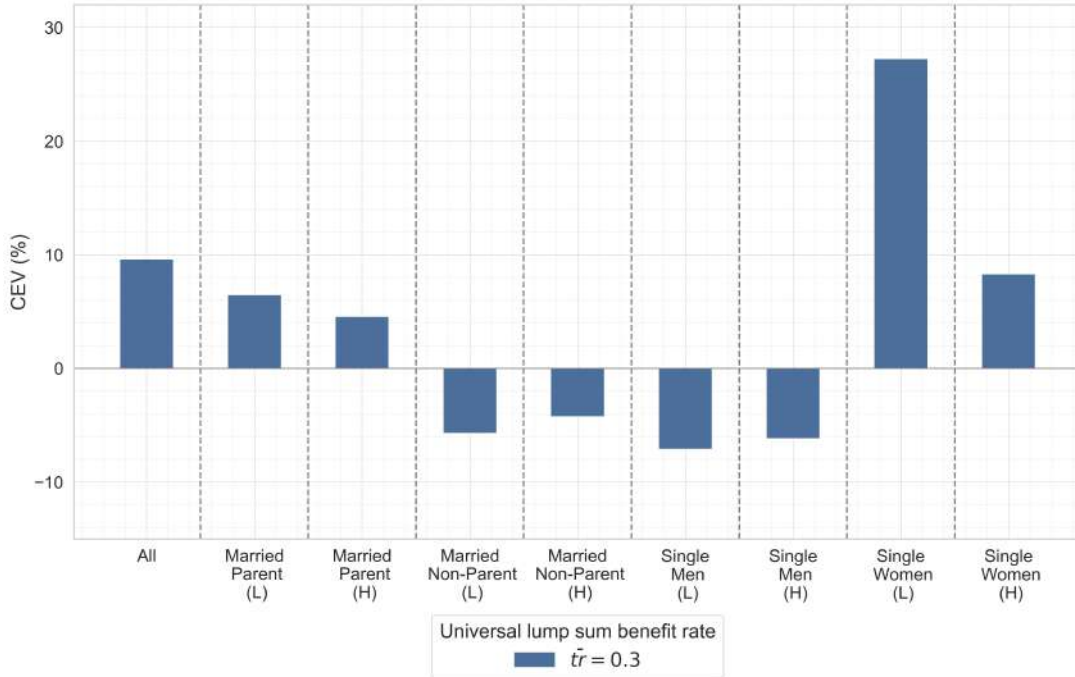


Figure 27: **Distribution of welfare changes under the optimal tax and child benefit system.**

Notes: As detailed in Subsection 4.1, all single men households are childless, and all single women households are single mothers.

6.3.2 Welfare effects across the three major reforms

Does the joint optimal tax and child benefit regime provide better welfare outcomes compared to the individual system reforms? Why is the transfer higher under the combined system optimization? And to what extent are these outcomes driven by the increased universal transfers to parents rather than the tax progressivity? To address these questions, I compare the distribution of welfare changes across the three key reforms: (i) the optimal tax system ($\tau^* = 0.1$) from Subsection 6.1, (ii) the optimal child benefit system ($\bar{tr}^* = 25\%$) from Subsection 6.2, and (iii) the joint optimal system ($\tau^* = 0.1$ and $\bar{tr}^* = 30\%$) from Subsection 6.3, as shown in Table 11. Additionally, to isolate the individual policy effects under the joint reform, I include welfare outcomes

from a non-optimal joint system that simply combines the individual optimal reforms ($\tau = 0.1$ and $\bar{t}r = 0.25$) without increasing the transfer amount to match that of the joint optimal reform (third row in Table 11).

Comparing welfare outcomes. In terms of overall and parental welfare impacts, the results in Table 11 indicate that the joint optimal design of taxes and child benefits yields significantly larger gains than the individual reforms. The welfare improvement under the joint system is 9.64%—1.3 times greater than the 7.39% achieved under the optimal child benefit system and 7 times the 1.38% increase under the optimal tax system. Similar gains are observed across parent groups, underscoring the importance of a holistic approach to designing tax and child benefit systems to effectively meet policy objectives.

Welfare (%)	All	Married Parent (L)	Married Parent (H)	Married Non-parent (L)	Married Non-parent (H)	Single Men (L)	Single Men (H)	Single Women (L)	Single Women (H)
$\tau^* = 0.1$	+1.38	−0.94	+0.25	−1.59	−0.56	−2.04	−1.40	+7.86	−1.42
$\bar{t}r^* = 25\%$	+7.39	+4.59	+3.50	−4.10	−3.95	−4.87	−4.35	+22.80	+2.59
$\tau=0.1, \bar{t}r=25\%$	+7.21	+5.95	+4.35	−4.40	−3.20	−5.15	−4.55	+16.09	+8.50
$\tau^*=0.1, \bar{t}r^*=30\%$	+9.64	+6.49	+4.59	−5.73	−4.26	−7.12	−6.21	+27.27	+8.32

Table 11: **Distribution of welfare changes across the three key reforms:** **First row:** Optimal tax reform; **Second row:** Optimal child benefit reform; **Third row:** Non-optimal combination of individual optimal reforms; **Fourth row:** Optimal joint tax and child benefit system.

Notes: Results are reported as changes relative to the levels in the benchmark economy. As detailed in Subsection 4.1, all single men households are childless, and all single women households are single mothers.

The key reform behind welfare changes. A comparison of the optimal tax system (first row) and the joint optimal system (fourth row) in Table 11 shows that under the joint optimal system, the universal lump-sum child benefit program (or universal FTB) is the primary driver of overall and parental welfare gains. The child benefit component alone significantly enhances welfare for all parents, more than compensating them for the associated tax burden. Low-education single mothers see the greatest improvement, with their welfare increasing by nearly 20pp higher than under the tax reform.

The situation reverses for non-parent households, who do not receive child-related transfers but bear the fiscal pressure of funding the system. The heavier tax load due to the optimal child benefit reform (relative to the status quo and the optimal tax regime) causes substantial welfare losses for non-parent households. Their welfare falls further under the joint optimal system due to the expanded child benefits, which exacerbate fiscal stress. For disadvantaged non-parent households, such as low-education childless couples, welfare losses reach −5.73%, exceeding those under the optimal tax system (−1.59%) by more than threefold and surpassing losses under the optimal child benefit reform (−4.1%) by 1.4 times. Thus, the joint optimal tax and child benefit system amplifies welfare gains for winners while deepening losses for losers, thereby worsening the inequitable redistribution problem.

The interaction between tax and child benefit systems under the joint optimal reform. The joint optimal tax and child benefit system prescribed a 5pp higher lump-sum transfer to parents compared to the standalone optimal child benefit system.

To understand the rationale behind the prescribed joint design, consider the optimal child benefit regime ($\bar{t}r = 25\%$) as the starting point. This regime generates the largest overall welfare improvement among the two individual reforms (first and second rows of Table 11). Welfare outcomes from the non-optimal policy combination (third row) demonstrate that simply incorporating lower tax progressivity ($\tau = 0.1$)—matching the optimal tax system—into the optimal child benefit regime ($\bar{t}r = 0.25$) yields notable welfare gains for better-off parents at the expense of their worse-off counterparts. In particular, high-education parents experience significant welfare improvements, especially high-education single mothers whose welfare increases from 2.59% to 8.5% relative to the benchmark level. Conversely, the reduced tax progressivity adversely affects low-education single mothers. The universal transfer disincentivizes their labor supply, resulting in lower average

market income. Since a more proportional tax scheme raises tax liabilities in lower income brackets, it reduces their disposable income and deteriorates their welfare increase (relative to the benchmark level) by one-third, from 22.8% to 16.09%. On net, these changes lead to a slight reduction in overall welfare, from 7.39% under the optimal child benefit regime to 7.21%.

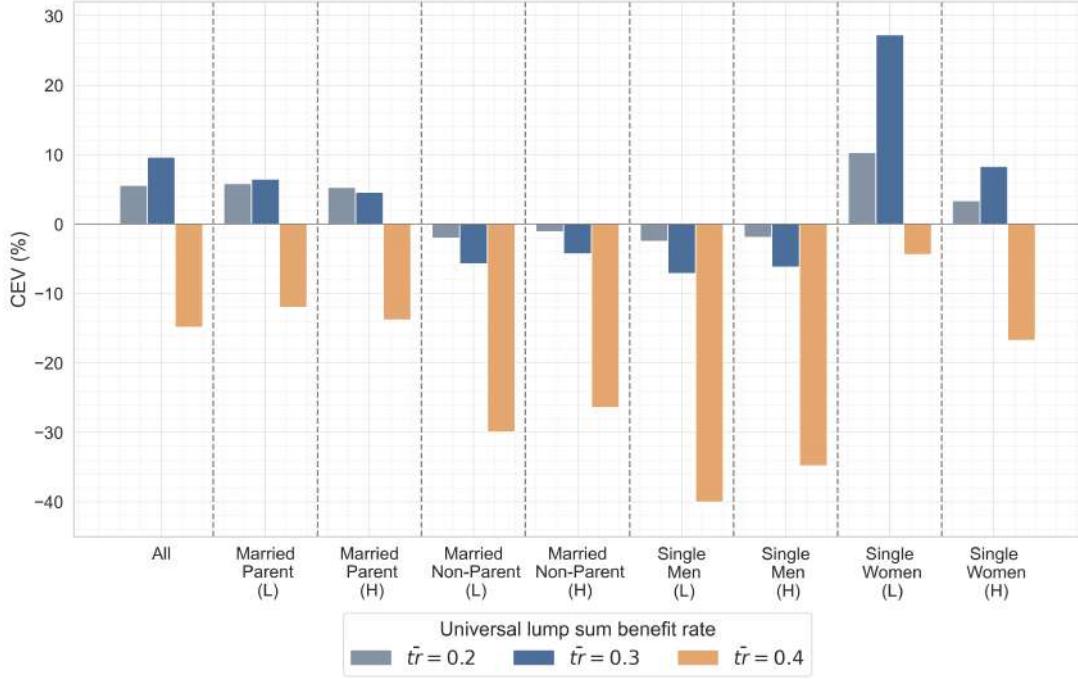


Figure 28: **Distributions of welfare changes under optimal tax progressivity ($\tau^* = 0.1$) and three different levels of universal child benefit payment rate ($\bar{t}r$).**

Notes: As detailed in Subsection 4.1, all single men households are childless, and all single women households are single mothers.

Given the significant loss incurred by single mothers under the tax reform, the joint optimal system compensates this group with a 5pp increase in the universal lump-sum child benefit payment. Comparing the third and fourth rows of Table 11 demonstrates that the additional transfer significantly increases single mothers' welfare to 27.27% without compromising the welfare gains of high-education parents achieved under the tax progressivity reform. Nonetheless, the higher tax burden to fund the more generous child benefits results in larger welfare losses for non-parents compared to those under the individual reforms.

Furthermore, Figure 28 indicates that as the universal lump-sum child benefit system expands, welfare declines across all demographics. The rising tax burden not only deteriorates welfare of non-parents but also negates the intended benefits for parent households. An overly generous system ultimately fails to deliver positive welfare outcomes for its target beneficiaries. Conversely, a reduced payment rate of $\bar{t}r = 20\%$ provides smaller gains for parents and does not maximize overall welfare, but it imposes significantly lower welfare costs on non-parents—about one-third of the losses they would experience under the optimal scenario.

Composition of welfare changes. Figure 29 illustrates that welfare changes are primarily driven by changes in consumption allocative efficiency (CEV_{CE}) as the generosity of universal child benefits varies. Notably, once the benefit rate exceeds the optimal level of $\bar{t}r^* = 30\%$, fiscal pressures take hold and result in declines in consumption allocative efficiency and thus overall welfare. For example, Table 10 shows that increasing the payment to 40% overburdens taxpayers, reflected by a steep 0.212 decrease in ζ and a 22.36% surge in the average tax rate. This fiscal strain depresses household consumption over the life cycle (Appendix Figure 57), leading to an approximately 15% decrease in both consumption allocative efficiency and overall welfare.

While consumption allocative efficiency dominates in most scenarios, moderate child benefit payments ($\bar{t}r \in \{20\%, 25\%, 30\%\}$)—including the optimal level—also yield positive leisure insurance effects (CEV_{LI}).

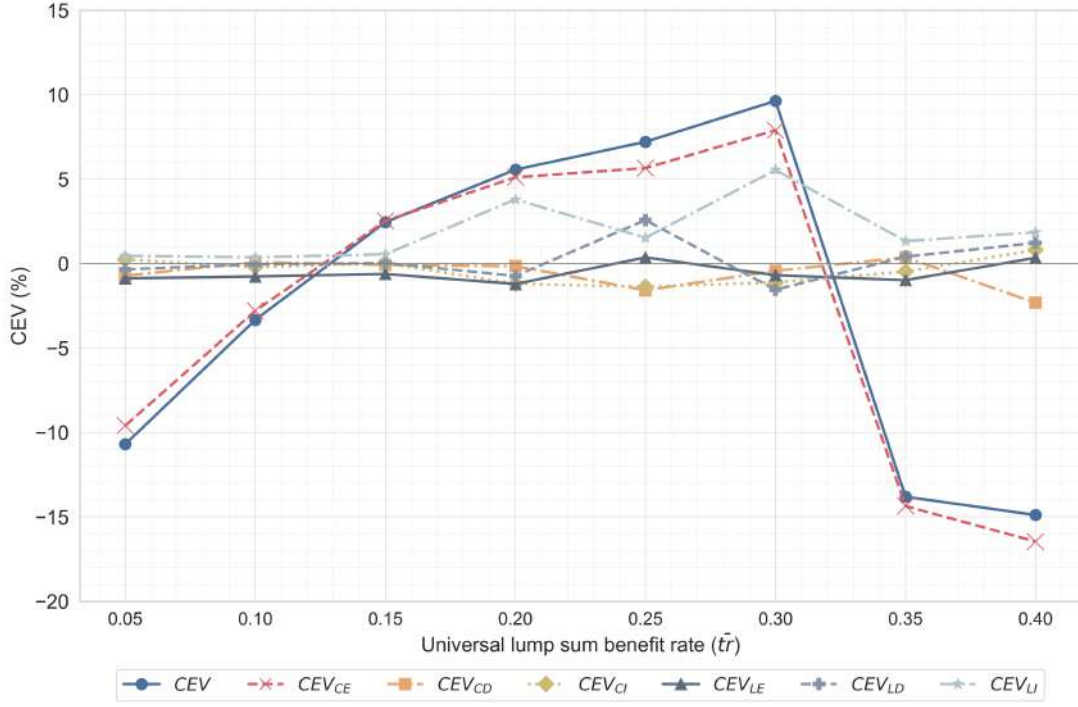


Figure 29: **Decomposition of overall welfare changes under the optimal tax progressivity ($\tau^* = 0.1$) across different payment rates of universal lump-sum child benefits (\tilde{tr}).**

This suggests that newborn households entering the post-reform economy experience better ex-post leisure outcomes relative to the status quo. As shown in Table 12, welfare improvements under the jointly optimized system ($\tau^* = 0.1$, $\tilde{tr}^* = 30\%$) are driven primarily by a 7.9% increase in consumption allocative efficiency and a 5.55% rise in leisure insurance. There are also negative effects on consumption distribution (CEV_{CD}) and consumption insurance (CEV_{CI}), along with adverse impacts on leisure allocative efficiency (CEV_{LE}) and distribution (CEV_{LD}), though these losses are relatively small.

Welfare (%)	CEV	CEV_{CE}	CEV_{CD}	CEV_{CI}	CEV_{LE}	CEV_{LD}	CEV_{LI}
$\tau^* = 0.1$	+1.38	+1.07	+0.03	+0.06	+0.04	+0.07	-0.07
$\tilde{tr}^* = 25\%$	+7.39	+5.47	+0.05	-0.32	-0.76	+0.13	+2.44
$\tau^* = 0.1, \tilde{tr}^* = 30\%$	+9.64	+7.90	-0.43	-1.12	-0.69	-1.55	+5.55

Table 12: **Decomposition of overall welfare changes under the three key reforms: Top row:** Optimal tax system; **Middle row:** Optimal child benefit system; **Bottom row:** Optimal tax and child benefit system.

Furthermore, Table 12 indicates that the optimal tax progressivity alone contributes a modest 1.07% increase in consumption allocative efficiency, with negligible impacts on other welfare components. It is the integration of the universal child benefits that allows the joint optimal reform to deliver significant improvements in consumption allocative efficiency and leisure insurance, albeit with modest losses in other welfare components.

These results reveal that the child benefit reform's positive effect comes primarily from allowing households to better smooth consumption over their life cycle, thus enhancing consumption allocative efficiency. Moreover, although leisure allocation becomes less efficient, households enjoy more favorable ex-post leisure outcomes in adverse circumstances compared to those under the initial steady state.⁵⁹ However, as average consumption and leisure rise post-reform, some demographic groups experience reduced ex-ante shares of consumption (CEV_{CD}) and leisure (CEV_{LD}). The decline in labor supply and human capital under the joint optimal system also weakens households' earnings potential and their ability to self-insure against negative shocks, thereby contributing to higher ex-post consumption risk (i.e., lower consumption insurance).

⁵⁹These adverse circumstances refer to realizations of bad states, such as low asset holdings and negative earnings shocks.

Composition of welfare changes by demographic. Figure 30 demonstrates that the primary drivers of welfare for most demographic groups under the joint optimal system are consistent with the composition of overall welfare changes. For instance, parent households benefit significantly from improved consumption allocative efficiency. Their consumption increases considerably during younger years, when child care responsibilities are most demanding (Figure 26). While some parents face reduced consumption at certain life stages, the reallocation of consumption throughout their life cycle generates a positive efficiency effect, leading to a welfare boost of at least 5%.

Single mothers, particularly those with low education, gain the most from the optimal joint design. They are also the only demographic group to experience substantial improvements in both consumption allocative efficiency (20%) and leisure insurance (22%). These gains arise partly from the universal child benefits they receive and the larger wealth buffers they accumulate under the reform (Figure 26). However, they also experience negative consumption insurance effects and adverse distributional outcomes in both consumption and leisure. The decline in consumption insurance likely reflects their increased reliance on child benefits and savings, which diminishes their labor efficiency units (Figure 25) and heightens their ex-post consumption risk. Additionally, the negative consumption and leisure distributional effects suggest that, despite their gains in absolute terms, single mothers still expect to consume less and work more relative to the post-reform population averages.

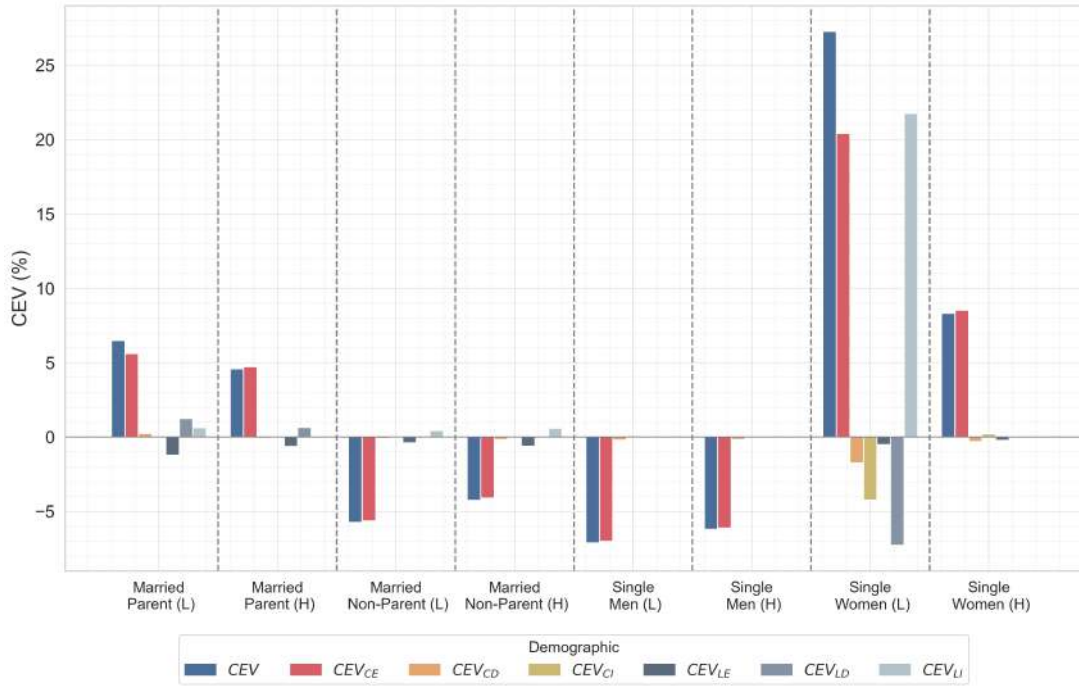


Figure 30: **Decomposed welfare changes by demographic under the optimal tax and child benefit system.**

Notes: As detailed in Subsection 4.1, all single men households are childless, and all single women households are single mothers.

These findings offer three insights. First, the proposed joint optimal design of tax and child benefit system outperforms the status quo and the individual reforms in terms of both overall and parental welfare improvements. This attests to the importance of coordinating policy design to achieve superior outcomes.

Second, there is a trade-off between overall welfare and equity. The joint optimal system redistributes welfare from non-parents to parents. I show that a less generous system may yield smaller overall and parental welfare gains but imposes lower costs on non-parents, making it a more politically and economically viable option in certain policy contexts. In contrast, a more generous system risks harming all households, including parents, as the increasing tax burden eventually outweighs the positive effects of child benefits. Hence, fiscal sustainability is crucial to safeguarding welfare for all, including transfer recipients.

Lastly, because optimality in this study is defined based on consumption and leisure, an optimal system

does not necessarily align with improvements in key macroeconomic performance indicators, such as female labor supply and output. Indeed, proposed optimal systems across the different policy settings in this study are associated with higher leisure and reduced output.

7 Conclusion

This paper studies the interaction between tax and child benefit systems, proposes an optimal joint design that maximizes ex-ante welfare, and evaluates its macroeconomic and distributional implications.

First, based on Australia’s policy context, the findings underscore the close interconnection between tax and child benefit systems. An optimal tax reform prescribes lower tax progressivity than the current level, promoting longer work hours and yielding moderate welfare improvements. However, this shifts tax liabilities toward lower income brackets, causing welfare losses for some disadvantaged parents. Isolated tax reforms redistribute solely along the income dimension, failing to address the unique child-related costs that parents face. As such, even when optimized, tax reforms alone may undermine the objectives of child benefit programs, highlighting the need to carefully evaluate their distributional effects on welfare program beneficiaries.

Second, assuming the existing Child Care Subsidy (CCS) structure remains intact, this study finds that a joint optimal tax and child benefit system combined reduced tax progressivity ($\tau = 0.1$) with a generous universal lump-sum benefit per child ($\bar{tr}^* = 30\%$ of average income). The joint reform offers larger parental and overall welfare improvements than standalone tax or child benefit reforms. This emphasizes the importance of policy coordination in improving overall welfare.

Third, the optimal joint policy design places a greater tax burden on non-parents to fund the expanded child benefit program, creating a trade-off between overall welfare and equity. Since parents constitute the majority and face unique child-related costs, optimizing for overall welfare inherently favors policies benefiting parents, often to the detriment of non-parents. A less generous system, while yielding smaller gains, imposes considerably lower costs on non-parents, potentially making it more politically viable. Conversely, overly generous transfers may fail to offset the adverse tax impacts, leading to welfare losses for all, especially vulnerable parent households such as low-education single mothers. Fiscal sustainability is thus critical for both non-recipients and recipients of transfers.

Lastly, the distributions of welfare changes under the three counterfactual reforms underscore the vulnerabilities of low-education parents, particularly single mothers. They experience drastic welfare changes in response to new policy environments, and their welfare outcomes significantly influence overall welfare results. This suggests that research on child-related programs should explicitly consider the well-being of low-education single mothers to more accurately assess policy impacts.

This analysis involves several caveats due to the modeling assumptions made for tractability and computational feasibility. First, the model and welfare definition abstract from male labor supply, fertility, marriage, and child quality decisions to focus on welfare of parent households and female labor supply decisions as a starting point. Second, assumptions about children and child care costs could be refined to better capture behavioral responses among older mothers. Third, transitory shocks are modeled with normally distributed innovations, though empirical evidence (e.g., [Tin and Tran \(2023\)](#) for Australia) suggests non-linear and non-Gaussian income dynamics. Fourth, the welfare of households along the transition path is not accounted for. Finally, the current joint system design is limited to tax progressivity and universal lump-sum child benefit rates. Expanding the policy space to include phase-out rates and income-test thresholds for means-tested child benefits and subsidies could lead to enhanced welfare outcomes and a more equitable distribution of benefits.

References

- ATKINSON, A. AND J. E. STIGLITZ (1976): “The Design of Tax Structure: Direct Versus Indirect Taxation,” *Journal of Public Economics*, 6(1-2), 55–75.
- BAKER, M., J. GRUBER, AND K. MILLIGAN (2008): “Universal Child Care, Maternal Labor Supply, and Family Well-Being,” *Journal of Political Economy*, 116, 709–745.
- BENABOU, R. (2000): “Unequal Societies: Income Distribution and the Social Contract,” *American Economic Review*, 90, 96–129.
- BHANDARI, A., D. EVANS, M. GOLOSOV, AND T. SARGENT (2021): “Efficiency, insurance, and redistribution effects of government policies,” Tech. rep., Working paper.
- BICK, A. (2016): “The Quantitative Role of Child Care for Female Labor Force Participation and Fertility,” *Journal of the European Economic Association*, 14, 639–668.
- BICK, A. AND N. FUCHS-SCHÜNDELN (2018): “Taxation and Labour Supply of Married Couples across Countries: A Macroeconomic Analysis,” *The Review of Economic Studies*, 85, 1543–1576.
- BLUNDELL, R., M. COSTA DIAS, C. MEGHIR, AND J. SHAW (2016): “Female Labor Supply, Human Capital, and Welfare Reform,” *Econometrica*, 84, 1705–1753.
- BORELLA, M., M. DE NARDI, M. PAK, N. RUSSO, AND F. YANG (2023): “FBBVA Lecture 2023. The Importance of Modeling Income Taxes over Time: U.S. Reforms and Outcomes,” *Journal of the European Economic Association*, jvad053.
- BORELLA, M., M. DE NARDI, AND F. YANG (2018): “The aggregate implications of gender and marriage,” *The Journal of the Economics of Ageing*, 11, 6–26.
- (2022): “Are Marriage-Related Taxes and Social Security Benefits Holding Back Female Labour Supply?” *The Review of Economic Studies*, 90, 102–131.
- BORELLA, M., M. D. NARDI, AND F. YANG (2020): “Are Marriage-Related Taxes and Social Security Benefits Holding Back Female Labor Supply?” Opportunity and Inclusive Growth Institute Working Papers 41, Federal Reserve Bank of Minneapolis.
- BRAUN, A., K. KOPECKY, AND T. KORESHKOVA (2017): “Old, Sick, Alone, and Poor: A Welfare Analysis of Old-Age Social Insurance Programmes,” *Review of Economics Studies*, 84, 580–612.
- CHATTERJEE, S. AND C. MICHELINI (1998): “Household Consumption Equivalence Scales: Some Estimates from New Zealand Household Expenditure and Income Survey Data,” *Australian & New Zealand Journal of Statistics*, 40, 141–150.
- CONESA, J. C., S. KITAO, AND D. KRUEGER (2009): “Taxing Capital? Not a Bad Idea after All!” *American Economic Review*, 99, 25–48.
- DIAMOND, P. A. (1998): “Optimal Income Taxation: An Example with a U-Shaped Pattern of Optimal Marginal Tax Rates,” *American Economic Review*, 88, 83–95.
- DOIRON, D. AND G. KALB (2004): “Demands for Childcare and Household Labour Supply in Australia,” Melbourne institute working paper series, Melbourne Institute of Applied Economic and Social Research, The University of Melbourne.
- (2005): “Demands for Child Care and Household Labour Supply in Australia,” *Economic Record*, 81, 215–236.
- FELDMAN, M. S. (1969): “The Effects of Taxation on Risk Taking,” *Journal of Political Economy*, 77.
- (1987): “Should Social Security Benefits Be Means Tested?” *The Journal of Political Economy*, 95(3), 468–484.
- FERRIERE, A., P. GRÜBENER, G. NAVARRO, AND O. VARDISHVILI (2023): “On the Optimal Design of Transfers and Income Tax Progressivity,” *Journal of Political Economy Macroeconomics*, 1, 276–333.
- GONG, X. AND R. BREUNIG (2017): “Childcare Assistance: Are Subsidies or Tax Credits Better?” *Fiscal Studies*, 38, 7–48.
- GUNER, N., R. KAYGUSUZ, AND G. VENTURA (2012a): “Taxation and Household Labour Supply,” *The Review of Economic Studies*, 79, 1113–1149.
- (2012b): “Taxing women: A macroeconomic analysis,” *Journal of Monetary Economics*, 59, 111 – 128, carnegie-NYU-Rochester Conference Series on Public Policy at New York University on April 15-16, 2011.
- (2020): “Child-Related Transfers, Household Labour Supply, and Welfare,” *The Review of Economic Studies*, 87, 2290–2321.
- (2023): “Rethinking the Welfare State,” *Econometrica*, 91, 2261–2294.

- HEATHCOTE, J., K. STORESLETTEN, AND G. L. VIOLANTE (2017): “Optimal Tax Progressivity: An Analytical Framework,” *Quarterly Journal of Economics*, 132(4), 1693–1754.
- HUBBARD, G. R., J. SKINNER, AND S. P. ZELDES (1995): “Precautionary Saving and Social Insurance,” *The Journal of Political Economy*, 103, 369–399.
- HÉRAULT, N. AND G. KALB (2022): “Understanding the rising trend in female labour force participation,” *Fiscal Studies*, 43, 341–363.
- ISKHAKOV, F. AND M. KEANE (2021): “Effects of taxes and safety net pensions on life-cycle labor supply, savings and human capital: The case of Australia,” *Journal of Econometrics*, 223, 401–432, annals issue: Implementation of Structural Dynamic Models.
- KAYGUSUZ, R. (2015): “Social Security and Two-earner Households,” *Journal of Economic Dynamics and Control*, 59, 163–178.
- KEANE, M. P. (2022): “Recent research on labor supply: Implications for tax and transfer policy,” *Labour Economics*, 77, 102026, european Association of Labour Economists, World Conference EALE/SOLE/AASLE, Berlin, Germany, 25 – 27 June 2020.
- KUDRNA, G., C. TRAN, AND A. WOODLAND (2022): “Sustainable and Equitable Pension with Means Testing in Ageing Economies,” *European Economic Review*, 141.
- MIRPLEES, J. A. (1971): “An Exploration in the Theory of Optimum Income Taxation,” *The Review of Economic Studies*, 38, 175–208.
- NEUMARK, D. AND E. POWERS (2000): “Welfare for the Elderly: the Effects of SSI on Pre-retirement Labor Supply,” *Journal of Public Economics*, 78, 51–80.
- NISHIYAMA, S. (2019): “The joint labor supply decision of married couples and the U.S. Social Security pension system,” *Review of Economic Dynamics*, 31, 277–304.
- RAMSEY, F. P. (1927): “A Contribution to the Theory of Taxation,” *The Economic Journal*, 37, 47–61.
- SAEZ, E. (2001): “Using Elasticities to Derive Optimal Income Tax Rates,” *Review of Economic Studies*, 68, 205–229.
- (2002): “The Desirability of Commodity Taxation Under Nonlinear Income Taxation and Heterogeneous Tastes,” *Journal of Public Economics*, 83, 217–230.
- TIN, D. AND C. TRAN (2023): “Lifecycle Earnings Risk and Insurance: New Evidence from Australia,” *Economic Record*, 99, 141–174.
- (2024): “Aggregate Implications of Child-related Transfers with Means-Testing,” *Working Paper*.
- TRAN, C. AND A. WOODLAND (2014): “Trade-Offs in Means-Tested Pension Design,” *Journal of Economic Dynamics and Control*, 47, 72–93.
- TRAN, C. AND N. ZAKARIYYA (2021a): “Tax Progressivity in Australia: Facts, Measurements and Estimates,” *Economic Record*, 97 (316), 45–77.
- (2021b): “Tax Progressivity in Australia: Facts, Measurements and Estimates,” *Economic Record*, 97(316).
- (2022): “Growth, Redistribution and Inequality: Lessons from Australia’s Three Decades of Uninterrupted Economic Growth,” *Working Paper*.

Appendix

A Data: Additional empirical results

A.1 Taxes, child benefits, and EATR

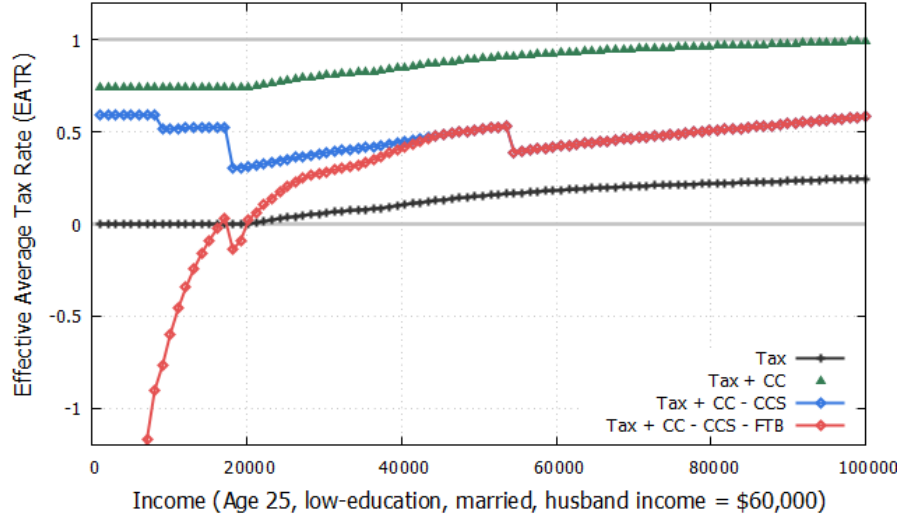


Figure 31: **Effective Average Tax Rate (EATR) schedule for a low-education (high school or below) young mother with two children:** Married with husband earning AUD 60,000.

Notes: The black line is the average income tax rate (ATR), including Low Income Tax Offset (LITO). The dotted green line is the EATR when the average gross child care cost is added to the ATR. The blue line is the EATR that incorporates the average net child care cost (accounting for the Child Care Subsidy (CCS)). The red line is the total EATR schedule when the average net child care cost and Family Tax Benefit (FTB) is accounted for.

Figure 31 depicts a simulated effective average tax rate (EATR) schedule for a young mother of two children whose husband earns approximately the average income (around \$60,000 in 2018). The figure shows that child benefits significantly increase progressivity in the EATR—the average rate of tax and child care costs net of child benefits—for the mother than what could be achieved under the income tax system alone. This enhanced progressivity stems from the generosity and non-mutually exclusive nature of the two benefit schemes. For example, for families situated below the average pre-government earnings, the FTB can account for up to 40% of their gross income. Moreover, through the CCS, low-income working parents could also receive up to 85% subsidy on their child care fees. Consequently, the child benefit programs in conjunction with the moderately progressive tax regime, where zero-tax zone extends until \$18,200 followed by a low marginal tax rate of 19% for earnings below \$37,000, result in a strong redistributive effect.

A.2 Taxes, child benefits, and effective marginal tax rates (EMTRs) over the life cycle

Effective marginal tax rates (EMTRs) for mothers vary over their life cycle due to the conditionality of child-related costs and transfers on the number and age of dependent children. Figure 32 presents two simulated life cycle EMTR profiles for a married mother with socioeconomic and demographic attributes identical to those in Figure 5, comparing scenarios where she: (i) stays at home (left panel), and (ii) works part-time (right panel).

In the stay-at-home scenario, the mother's EMTR is initially high, driven by child care fees and the phase-out of child benefits. While the marginal tax rate (MTR) is nil since her first dollar earned falls within the zero-tax bracket, the EMTR peaks early in her economic life. With her first child born at age 21 and her second child three years later, high hourly child care fees elevate her EMTR. However, the EMTR begins to decline

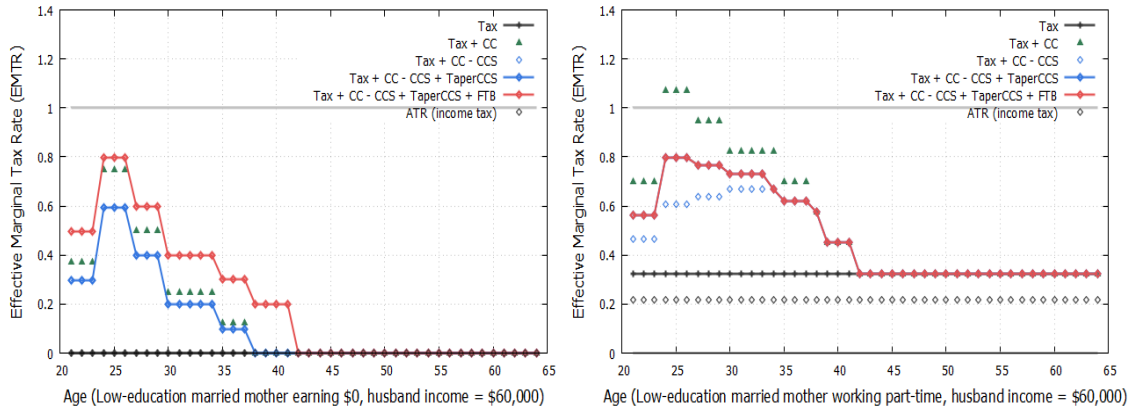


Figure 32: Life cycle profiles of Effective Marginal Tax Rate (EMTR) for a low-education (high school or below) mother with two children whose husband earns \$60,000: Left Panel—She stays at home; Right Panel—She works part-time.

Notes: These lines show the cumulative effects, stacked successively. The black dotted line is the average income tax rate (ATR). The black solid line is the marginal tax rate (MTR), including Low Income Tax Offset (LITO). The dotted green line is the EMTR when the marginal rate of the gross child care cost (CC) is added on top of the MTR. The light dotted blue line is the EMTR that also incorporates the CCS. The heavy solid blue line accounts for both the CCS and its phase-out rate. The solid red line is the total EMTR schedule when the FTB's phase-out rate is included.

by age 30 as her children age and child care costs decrease. The CCS partially offsets child care costs, reducing her EMTR, but the FTB adds approximately 20 cents to the EMTR through its phase-out rate, raising the profile beyond what arises naturally from child care expense.

In the part-time scenario, the MTR rises to 32.5%, but the joint effects of the FTB and CCS are more favorable. Because the CCS rate scales with work hours, it more than halves her EMTR from child care costs, despite her family income being within the subsidy's phase-out zone. Conversely, the FTB has no influence on her EMTR profile in this scenario, as her family income exceeds the FTB's cutout point (i.e., the FTB has completely phased out). Consequently, in this case, the means-tested child benefits lower her overall EMTR profile, thus reducing the work disincentives from MTR and child care costs.

These observations reveal that the combined effects of the taxes and child benefits are heterogeneous and non-linear over the life cycle. In most cases, means-testing weakens the work incentive effects of the tax-free zone and the subsidies.

B Deviations from optimal progressivity: Supplementary results

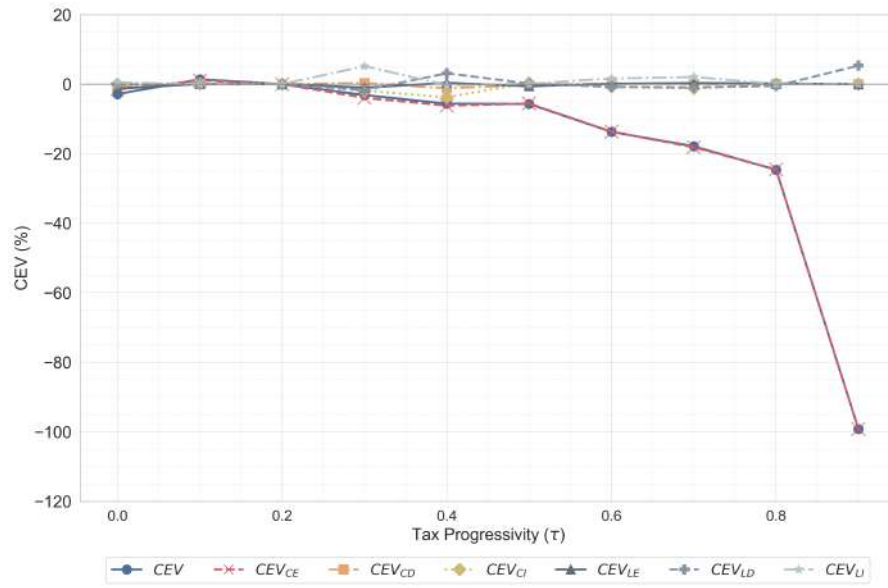


Figure 33: Decomposition of welfare changes over tax progressivity under the benchmark means-tested child benefits.

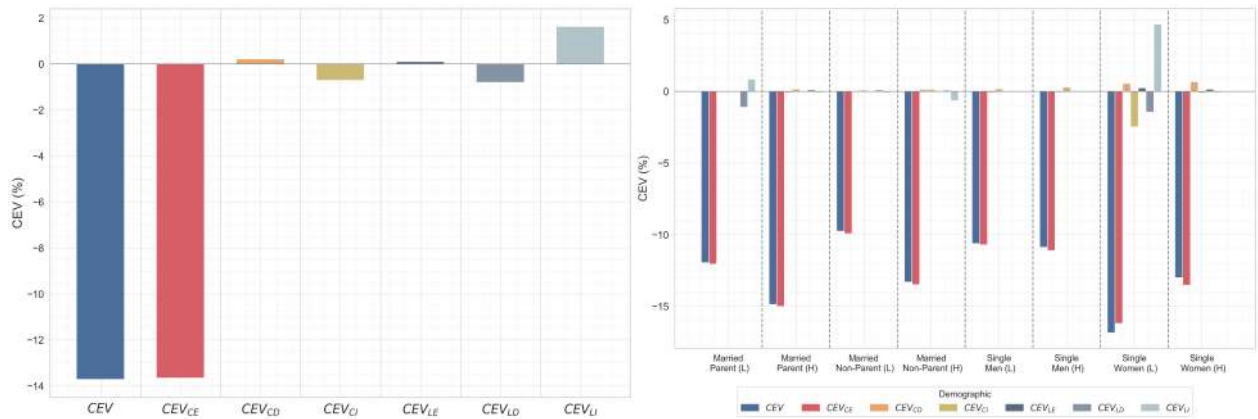


Figure 34: Decomposition of welfare changes under the benchmark means-tested child benefits (FTB and CCS) and a highly progressive tax regime ($\tau = 0.6$). Left panel: Overall; Right panel: By demographic.

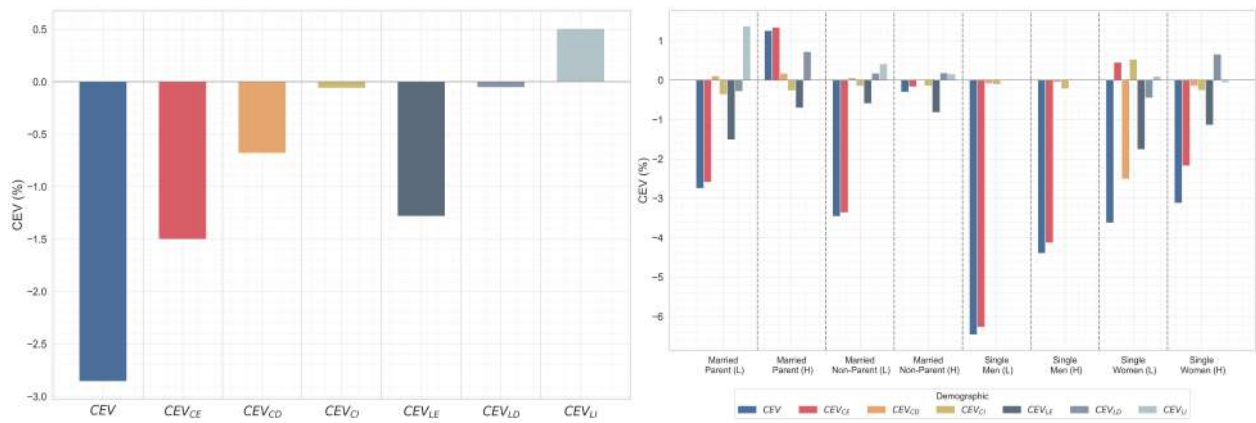


Figure 35: Decomposition of welfare changes under the benchmark means-tested child benefits (FTB and CCS) and a proportional tax regime ($\tau = 0$). Left panel: Overall; Right panel: By demographic.

C Optimal child benefits under the benchmark tax progressivity: Supplementary results

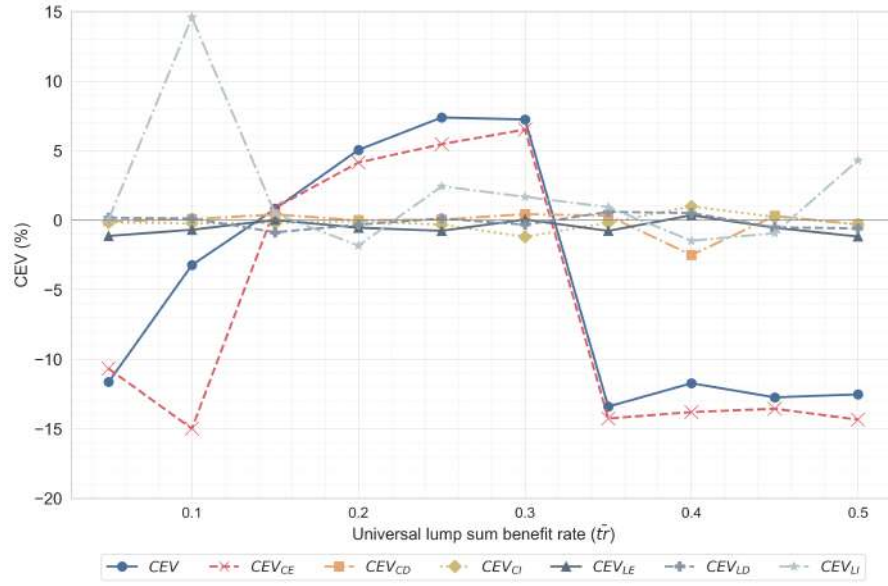


Figure 36: Decomposition of overall welfare changes over different payment rates of universal lump-sum child benefits (\bar{tr}) under the benchmark tax progressivity ($\tau = 0.2$).

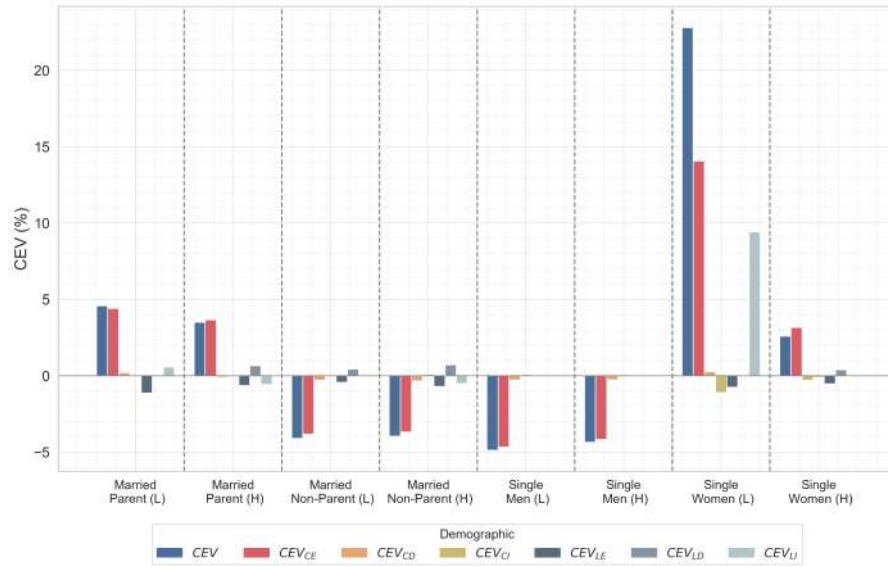


Figure 37: Decomposed welfare changes under the optimal child benefit system ($\bar{tr}^* = 25\%$) and benchmark tax progressivity ($\tau = 0.2$) by demographic.

D Optimal taxes and child benefits: Supplementary results

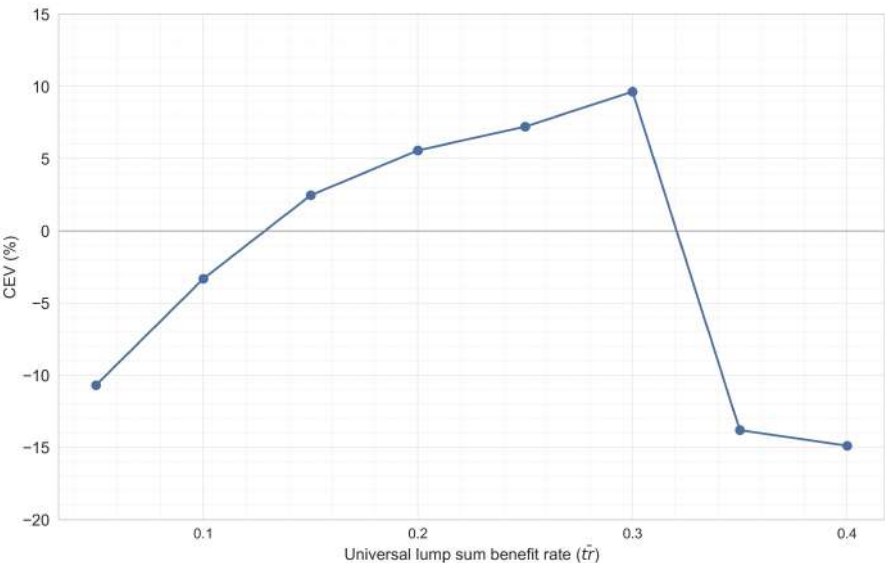


Figure 38: Overall welfare changes over different payment levels of universal lump-sum child benefits (\bar{tr}) under the optimal tax progressivity ($\tau^* = 0.1$).

E Simple model: Derivations

E.1 Working-age households' intra-temporal trade-off equation (50)

The First-Order Conditions for working-age households are:

$$u'_{\tilde{c}} = m \times p \iota_{\lambda, \theta} \quad (79)$$

$$u'_{1-n} = m \times w e_{\theta, \ell}^f \left(1 - EMTR_{yf, \lambda}(n, a)\right) \quad (80)$$

$$\beta E \left[\left(1 + r + EMTR_{a+, \lambda}(n, a)\right) \times u'_{\tilde{c}+} \mid \lambda, \eta^m, \eta^f \right] = \frac{p+ \times \iota_{\lambda, \theta+}}{p \times \iota_{\lambda, \theta}} \times u'_{\tilde{c}} \quad (81)$$

where $\tilde{c} = \frac{c}{\iota_{\lambda, \theta}}$ is the scaled household consumption; u'_i denotes the marginal utility with respect to a decision variable $i \in \{\tilde{c}, 1-n\}$; $p = 1 + \tau_c$ is the price of consumption goods; m is the Lagrange multiplier; and $EMTR_{yf, \lambda}(n, a)$ and $EMTR_{a+, \lambda}(a_+)$ are the effective marginal tax rates on labor and capital earnings, respectively. Because male labor supply is exogenous, Equation (80) does not apply to single-male households ($\lambda = 3$).

Note that, $EMTR_{yf, \lambda}(n, a)$, $EMTR_{a+, \lambda}(a_+)$ and $NLI_{\lambda}(n, a)$ differ by family type. Furthermore, the progressive income tax scheme $T_{\lambda}(n)$, the means-tested child benefits (FTB and CCS), and the Age Pension program result in non-linear $EMTR_{yf, \lambda}(n, a)$ and $NLI_{\lambda}(n, a)$ with respect to labor, and non-linear $EMTR_{a+, \lambda}(a_+)$ with respect to future asset holdings. They are expressed as

$$EMTR_{yf, \lambda}(n, a) = \frac{\partial T_{\lambda}}{\partial y^f}(n) + \mathbf{1}_{\{\lambda=1,4\}} \left[\frac{CE_{\theta}(n, a)}{w e_{\theta, \ell}^f} + \left(wn \times \frac{\partial sr}{\partial y^f}(n, a) - \frac{n}{e_{\theta, \ell}^f} \times \frac{\partial sr}{\partial n}(n, a) \right) \sum_{i=1}^{nc_{\theta}} \kappa_i \right] \\ + \mathbf{1}_{\{\lambda=1,4\}} \left(nc_{\theta} \times \frac{\partial tr^A}{\partial y^f}(n, a) + \frac{\partial tr^B}{\partial y^f}(n, a) \right) \quad (82)$$

$$EMTR_{a+, \lambda}(a_+) = r \times \frac{\partial T_{\lambda}}{\partial (ra_+)}(a_+) \\ + \mathbf{1}_{\{\lambda=1,4\}} \left(r \times \frac{\partial tr^A}{\partial (ra_+)}(a_+) + wn_+ r \times \frac{\partial sr}{\partial (ra_+)}(a_+) \sum_{i=1}^{nc_{\theta+}} \kappa_{i+} \right) \quad (83)$$

$$NLI_{\lambda}(n, a) = (1+r)a + \mathbf{1}_{\{\lambda=1,4\}} \left(nc_{\theta} \times tr^A(n, a) + tr^B(n, a) \right) \quad (84)$$

Equations (79) and (80) give us the intra-temporal trade-off condition between consumption and leisure:

$$\frac{u'_{1-n}}{u'_{\tilde{c}}} = \frac{w e_{\theta, \ell}^f}{p \iota_{\lambda, \theta}} \left(1 - EMTR_{yf, \lambda}(n, a)\right) \quad (85)$$

Solving (85) with the utility functions from Subsection 4.2 yields the household total consumption as a function of female labor supply

$$c(n, a) = \frac{\nu}{1-\nu} \frac{w e_{\theta, \ell}^f}{p} \left(1 - EMTR_{yf, \lambda}(n, a)\right) (1-n) \quad (86)$$

Equation (50) from the working-age household problem in Subsection 4.7 can then be derived by solving a system of two equations: (i) the consumption function (86), and (ii) the household budget constraint (49).

F Extensions

F.1 Optimal progressivity with baseline universal child benefits

I consider a child benefit reform termed *baseline universal child benefits*, proposed by Tin and Tran (2024), where means-testing from both the FTB and CCS is eliminated but demographic eligibility criteria and the baseline payment rates of the two programs are retained.⁶⁰ As summarized in Table 5, unlike in Tin and Tran (2024), this reform is welfare deteriorating even when implemented together with an optimal tax progressivity. This segment discusses the similarities and differences between findings of the two papers, including potential causes behind the divergence.

<i>Aggregate implications of the baseline universal child benefits</i>			
	$\tau = 0$	$\tau = 0.2$	$\tau = 0.5$
CCS size, %	+90.09	+133.30	+56.98
FTB size, %	+122.22	+122.22	+122.22
Average tax rate, pp	+4.84	+5.21	+10.04
Tax scale (ζ)	-0.003	-0.031	-0.093
Fe. LFP, pp	-4.35	+0.21	+5.36
Fe. Hour, %	+7.19	+0.95	-8.42
Fe. H. cap, %	+0.99	+1.13	+0.03
Cons (C), %	+0.50	+0.92	-0.42
Output (Y), %	+0.24	+0.41	-0.28
Welfare (CEV), %	-1.96	-1.38	-6.50

Table 13: **Aggregate implications of the baseline universal child benefits at three tax progressivity levels: $\tau = 0$, $\tau = 0.2$, and $\tau = 0.5$.**

Notes: Results are reported as changes relative to the levels in the benchmark economy.

Macroeconomic outcomes, welfare effects and their composition at the aggregate level. At the benchmark progressivity of $\tau = 0.2$, the baseline universal child benefits improve female labor supply, human capital, consumption, and output (Table 13). However, removing means-testing causes a significant expansion in both the FTB and the CCS programs—by 133.3% and 122.22%, respectively—despite the demographic criteria being retained to curb benefit spending. Funding this expansion necessitates increased tax revenue, resulting in a higher overall tax burden on all workers, as reflected by a 0.031 point decrease in the tax scale parameter ζ .⁶¹ Consequently, the average tax rate rises by 5.21%, dampening the intended work incentives from removing means-testing. In essence, while the reform eliminates wage distortions caused by means-testing, it simultaneously introduces larger tax liabilities and distortions. These counteracting forces help explain the relatively modest increases in female labor supply, output, and consumption.

Despite some aggregate improvements, the policy results in an overall welfare loss of 1.38%. Figure 39 shows further that only by maintaining the status quo tax progressivity of $\tau = 0.2$ can the welfare losses under the new child benefit system be minimized. Any deviation from the current progressivity leads to greater losses, stemming from declines in consumption allocative efficiency (CEV_{CE}), especially as the tax system becomes more progressive and tax burden increases (see Subsection 6.1.1).

Distribution of welfare changes and their composition by demographic. Aligned with the composition of the overall welfare changes, Figure 40 shows that, at the benchmark tax progressivity of $\tau = 0.2$, both winners and losers under this new regime experience welfare changes driven mainly by consumption allocative efficiency. Moreover, except for single men who do not make labor decisions in the model, all demographic groups also experience moderate losses from reduced leisure allocative efficiency.

For non-parents, who are not eligible for child benefits, these losses are attributable solely to the increased overall tax burden, which deteriorates their allocative efficiency in both consumption and leisure. Among

⁶⁰Details related to demographic criteria and their effects on child benefit payments are provided in Subsection H.3 in the Appendix.

⁶¹See explanation in Subsection 4.5.1.

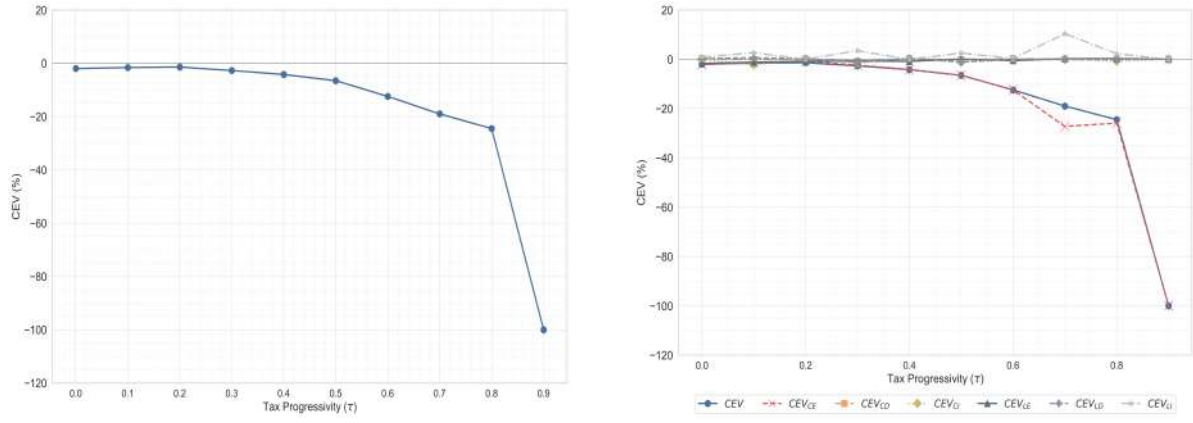


Figure 39: Overall (left panel) and decomposed welfare changes (right panel) over tax progressivity under the baseline universal child benefits.

parents, welfare outcomes vary, with couples benefiting while singles face losses. For brevity and comparability with [Tin and Tran \(2024\)](#), the following discussion focuses on single mothers—the primary target of child benefit programs—who fare worse than other groups.

To understand this outcome, recall that single mothers lack family insurance and have limited self-insurance capacity through work and savings due to child-related costs and early parenthood, which penalize their household consumption. Furthermore, since the pre-reform child benefits are means-tested based on family income, single mothers' earnings often fall below the income-test threshold, implying they faced no wage distortions and likely already received full child benefits under the status quo. As a result, the baseline universal reform does little to enhance their benefits or reduce wage distortions, thus offering few advantages to offset the higher tax burden under the new regime. These factors contribute to the significant welfare losses for single mothers.

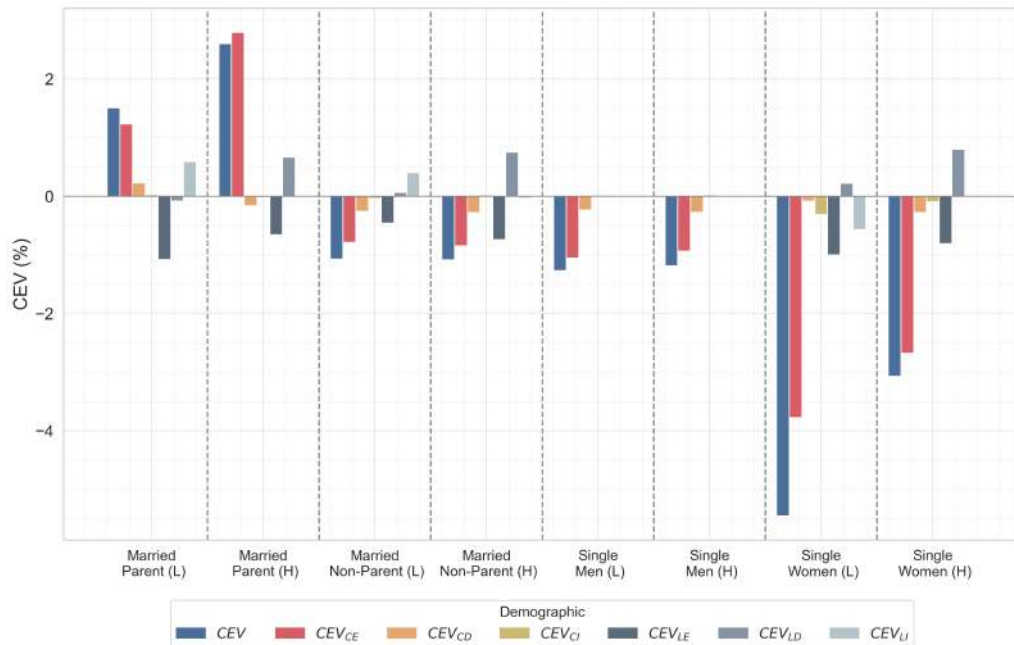


Figure 40: Decomposition of welfare changes by demographic under the baseline universal child benefits at the benchmark tax progressivity level ($\tau = 0.2$).

Ultimately, the reform redistributes welfare from single and non-parent households to married parent households, creating an inequitable distributional outcome. As illustrated in [Figure 41](#), adjusting tax progressivity

does not address the problem. Increasing progressivity to $\tau = 0.5$ only exacerbates the already unfavorable welfare outcome, leading to economy-wide welfare losses of at least 5% for all household types. In contrast, a proportional tax regime merely shifts the loss from low-education single mothers to low-education married parents.

Similarities and differences to Tin and Tran (2024). These findings, particularly in terms of equity outcomes, resonate with Tin and Tran (2024), who also find that the baseline universal child benefit scheme disadvantages single mothers due to increased tax pressure. Their analysis reveals that adjusting the universal payment rate does not resolve the inequity, and this study shows that altering tax progressivity similarly fails to mitigate the issue.

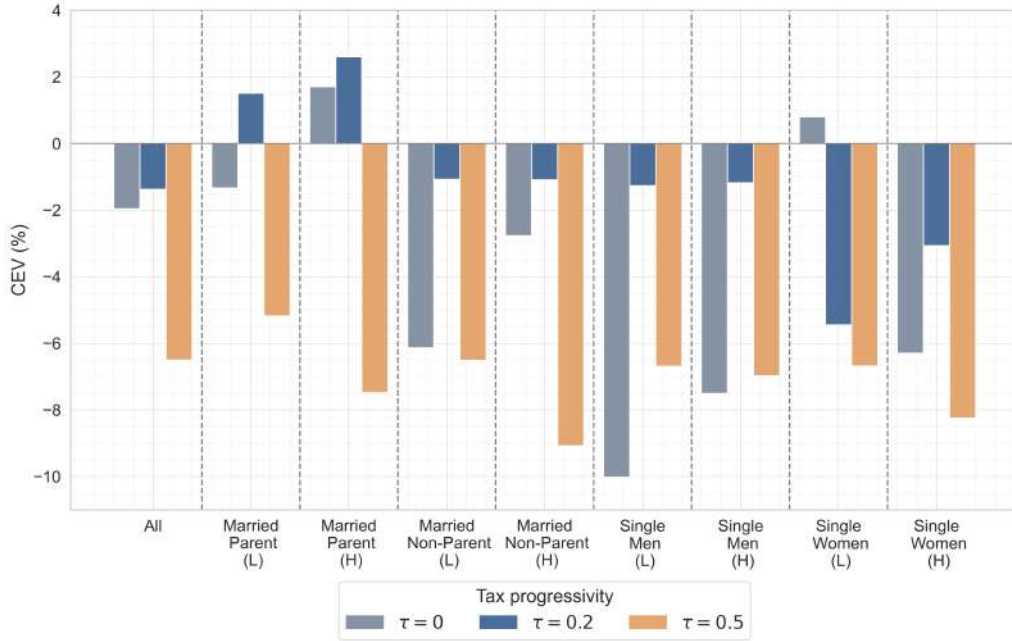


Figure 41: **Distributions of welfare changes by demographic under the baseline universal child benefits for three tax progressivity levels.** Blue bars: Proportional ($\tau = 0$); Gray bars: Benchmark, moderate progressivity ($\tau = 0.2$); Orange bars: High progressivity ($\tau = 0.5$).

However, the overall welfare outcomes differ between the two studies. Tin and Tran (2024) report a small positive welfare effect, whereas the results here indicate a welfare decline. This divergence can be partially attributed to the differences in female labor supply modeling. In Tin and Tran (2024), where labor decisions are limited to part-time and full-time employment, eliminating means-testing significantly increases female labor supply, expanding the tax base and easing the fiscal strain of the universal regime. The average tax rate in their setting increases by 4.2pp.

In contrast, in the current study's configuration, where both the intensive and extensive margins of female labor supply are enabled, their trade-off results in a weaker overall labor supply response compared to Tin and Tran (2024). For instance, Figure 42 shows that married parents tend to increase participation but reduce work hours, while low-education single mothers work longer hours but with fewer of them participate in the workforce. The weaker tax base expansion helps explain the larger increase in the average tax rate (5.2pp) in the current setting. The higher tax burden disproportionately affects single mothers, contributing to larger losses in their welfare and overall welfare. These results underscore the importance of modeling the intensive margin of female labor supply decisions to capture the policy effects on low-education single mothers responses and welfare outcomes. Furthermore, despite some variations in the aggregate results, the qualitatively consistent distributional outcomes across both studies provide confidence that the findings concerning the redistributive effects of universal child benefits on vulnerable households are robust.

In conclusion, means-testing plays a pivotal role in alleviating tax burden and enhancing overall welfare.

The tax savings due to means-testing is not only beneficial for non-parents but results in significant welfare improvements for vulnerable parents, particularly low-education single mothers. In this paper, the removal of means testing renders the baseline universal child benefits a lose-lose reform, irrespective of tax progressivity. This also demonstrates that the baseline child benefits for parents are insufficient to justify the increased overall tax burden from universalizing both the FTB and CCS. Subsection 6.3.1 explores an alternative environment, where the CCS is kept unchanged, while tax progressivity and lump-sum child benefit (FTB) payment rates are jointly optimized.

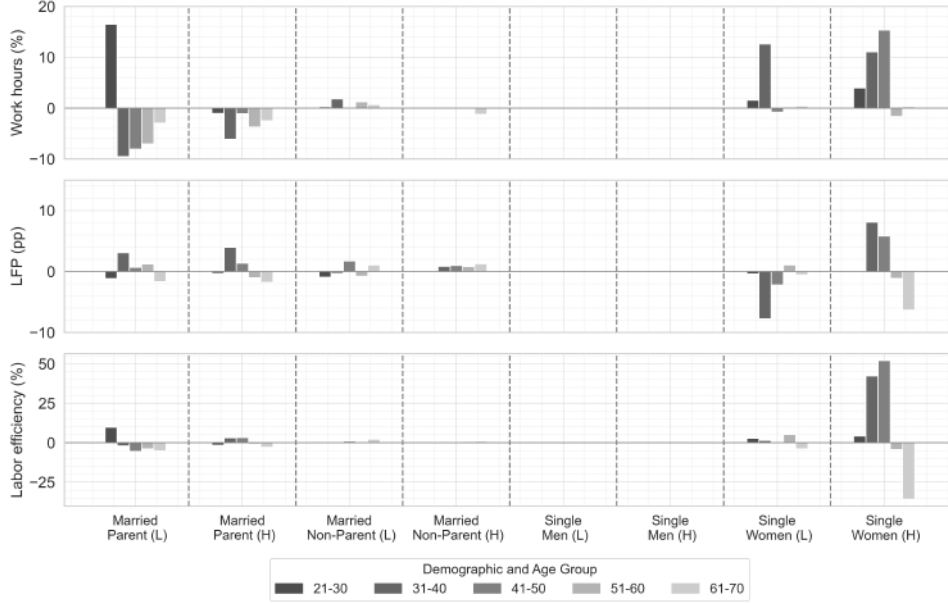


Figure 42: Female labor supply responses by age and demographic under the baseline universal child benefits and benchmark tax progressivity ($\tau = 0.2$): (Top: work hours, Middle : labor force participation, Bottom : labor efficiency)

F.2 The role of lump-sum child transfers (FTB) and child care subsidies (CCS)

Previous experiments show the dominance of consumption allocative efficiency (CEV_{CE}) in driving welfare changes, both at the aggregate level and across demographics. Most reforms considered have minimal impact on the distributional and insurance components of welfare, in terms of both consumption (CEV_{CD} and CEV_{CI}) and leisure (CEV_{LD} and CEV_{LI}).

A plausible explanation could be households' ability to adjust their labor supply and savings in response to policy changes, allowing them to maintain relatively stable ex-ante shares and ex-post risks in consumption and leisure under different reform scenarios. For vulnerable parent groups, child benefit programs that relax constraints on their capacity to self-insure through work and savings—such as child-related costs—may help them achieve similar stability. The consistent presence of the FTB and CCS in the counterfactual experiments likely contributes to the relatively muted effects of reforms on equity and insurance.

Thus, to better understand how each program may have influenced welfare outcomes across the three reforms, I extend the analysis by examining the composition and distribution of welfare changes in two policy experiments: one where means-tested lump-sum child benefits (FTB) are removed, and another where child care subsidies (CCS) are removed from the status quo system.

I find that eliminating either the FTB or the CCS brings about significant overall welfare losses in the model economy, with potential reductions of up to 100% in consumption equivalent terms. However, the magnitude and mechanisms behind these losses differ greatly between the two reforms.

The left panel of Figure 43 reveals that removing the FTB causes an approximately 20% loss in overall welfare, primarily driven by a decline in consumption allocative efficiency (CEV_{CE}). Contributions from other

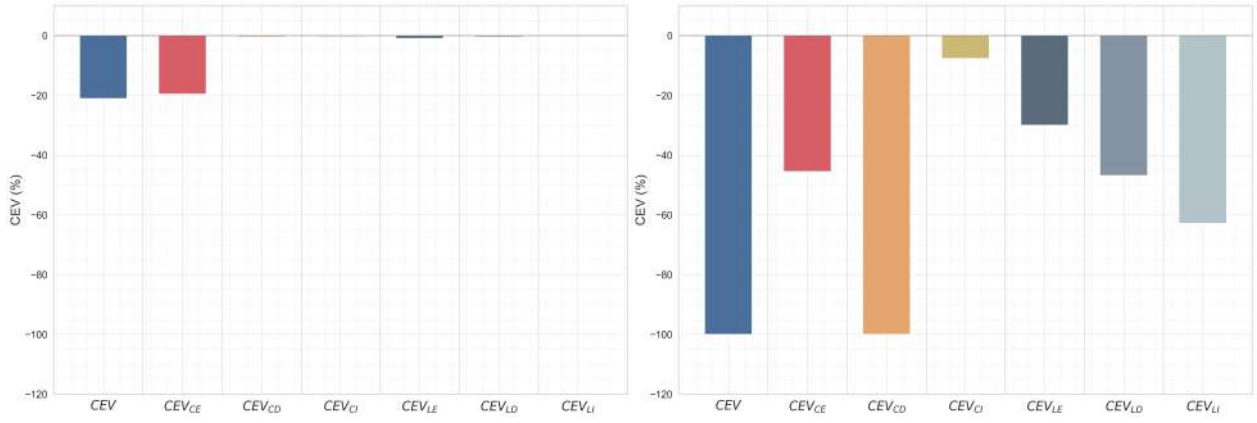


Figure 43: **Decomposition of welfare changes by demographic under the benchmark tax progressivity ($\tau = 0.2$) with the removal of one child benefit program: Left panel: FTB removal; Right panel: CCS removal.**

components of welfare are minimal. In contrast, the absence of the CCS, as evident in the right panel of Figure 43, produces a significantly greater welfare loss, reaching up to 100%, due to a mixture of factors beyond just consumption efficiency.

<i>Aggregate implications of removing the FTB or the CCS</i>		
	<i>Remove FTB</i>	<i>Remove CCS</i>
CCS size, %	+92.86	-100
FTB size, %	-100	+2.78
Average tax rate, <i>pp</i>	+4.91	+4.01
Tax scale (ζ)	-0.020	+0.003
Fe. LFP, <i>pp</i>	+1.57	-2.69
Fe. Hour, %	+8.58	+5.69
Fe. H. cap, %	+1.34	+0.07
Cons (C), %	-0.37	-0.17
Output (Y), %	+0.18	-0.30
Welfare (CEV), %	-21.06	-100

Table 14: **Aggregate implications of the removing either the FTB or the CCS under the benchmark tax progressivity ($\tau = 0.2$).**

Notes: Results are reported as changes relative to the levels in the benchmark economy.

The relatively stable tax scale parameter ζ in Table 14 suggests that these welfare losses must arise directly from the removal of the child benefit programs themselves, rather than indirectly through changes in the overall tax burden. Additionally, aggregate consumption levels decline only modestly—by 0.37% with the removal of the FTB and 0.17% with the removal of the CCS, prompting the question of why such drastic welfare losses occur.

Figure 44 identifies the welfare declines among low-education married and single mother households as the primary drivers of the overall welfare reduction under these reforms. Removing the FTB results in a 40% welfare loss for low-education single mothers and a 20% loss for their high-education counterparts, mainly due to a reduction in consumption allocative efficiency. The impact of removing the CCS is even more severe, resulting in welfare losses equivalent to 100% in consumption terms for low-education parents. Furthermore, the absence of the CCS significantly increases the importance of distributional and insurance effects in explaining the welfare losses among parents.

Several factors may explain the heavy dependence of these households on subsidies, including (i) limited or nonexistent family insurance, (ii) constrained self-insurance through female labor supply and savings due to early arrival of children and associated costs, and (iii) the inability to borrow in younger years due to credit constraints. These constraints make low-education parents particularly vulnerable compared to the rest of the population. The substantial welfare losses they face—through drastically declined ex-ante shares and height-

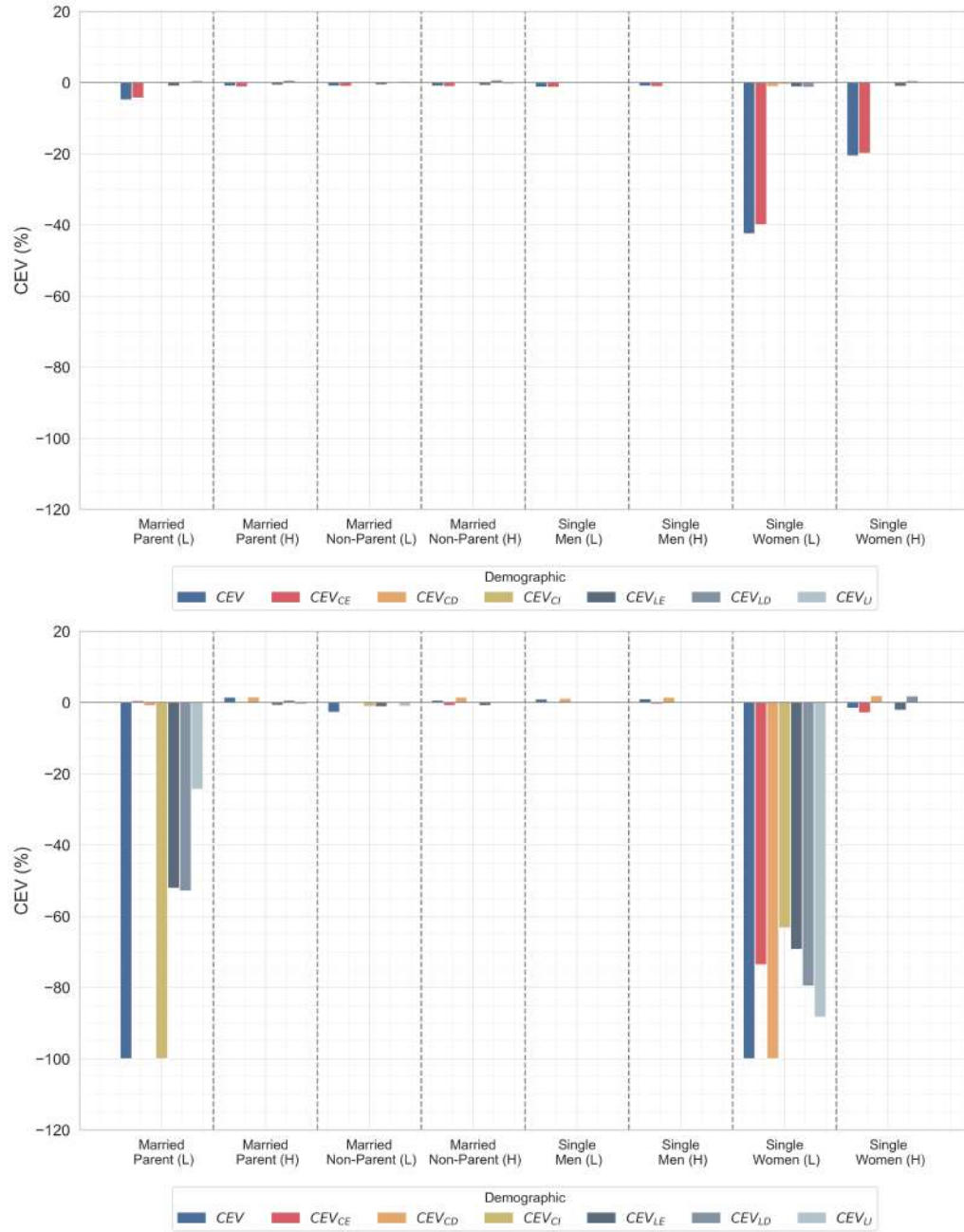


Figure 44: Decomposition of welfare changes by demographic in the absence of one of the child benefit programs under the benchmark tax progressivity ($\tau = 0.2$). **Top panel:** FTB removal; **Bottom panel:** CCS removal.

ened ex-post risks in consumption and leisure—underscore the critical role the CCS plays in promoting equity and insurance. By reducing child care costs, the CCS alleviates labor supply constraints for single mothers, facilitating their workforce participation and human capital accumulation. The enhanced self-insurance capacity raises their ex-ante shares of consumption and leisure. Moreover, by improving their labor earnings and savings capacity, the subsidies help mitigate these households' ex-post risks, leading to better consumption and leisure outcomes in the face of adverse shocks.

Why does the FTB not offer the same support? There are two plausible reasons. First, lump-sum child benefits are only available while children are dependent, limiting their ability to provide long-term consumption and leisure insurance. Second, the program's means-testing and benefit structure create work disincentives during early phases of life, thus diminishing human capital potentials. Because low-education families must rely on labor earnings once they exit the FTB program, these factors likely contribute to the program's ineffectiveness in boosting their ex-ante consumption and leisure shares or enhancing their ability to self-insure against shocks.

In addition to demonstrating the importance of child benefits for vulnerable parents, this analysis highlights the distinct roles of lump-sum child benefits (FTB) and child care subsidies (CCS). While the FTB primarily enhances consumption allocative efficiency, the CCS is vital for equity and insurance. These differences suggest that policies could be more effectively tailored to specific economic contexts. For example, in economies with weaker private insurance mechanisms, child care subsidies may be more effective in improving long-term parental and overall welfare.

G Quantitative analysis: Supplementary results

G.1 Optimal tax progressivity with benchmark child benefits

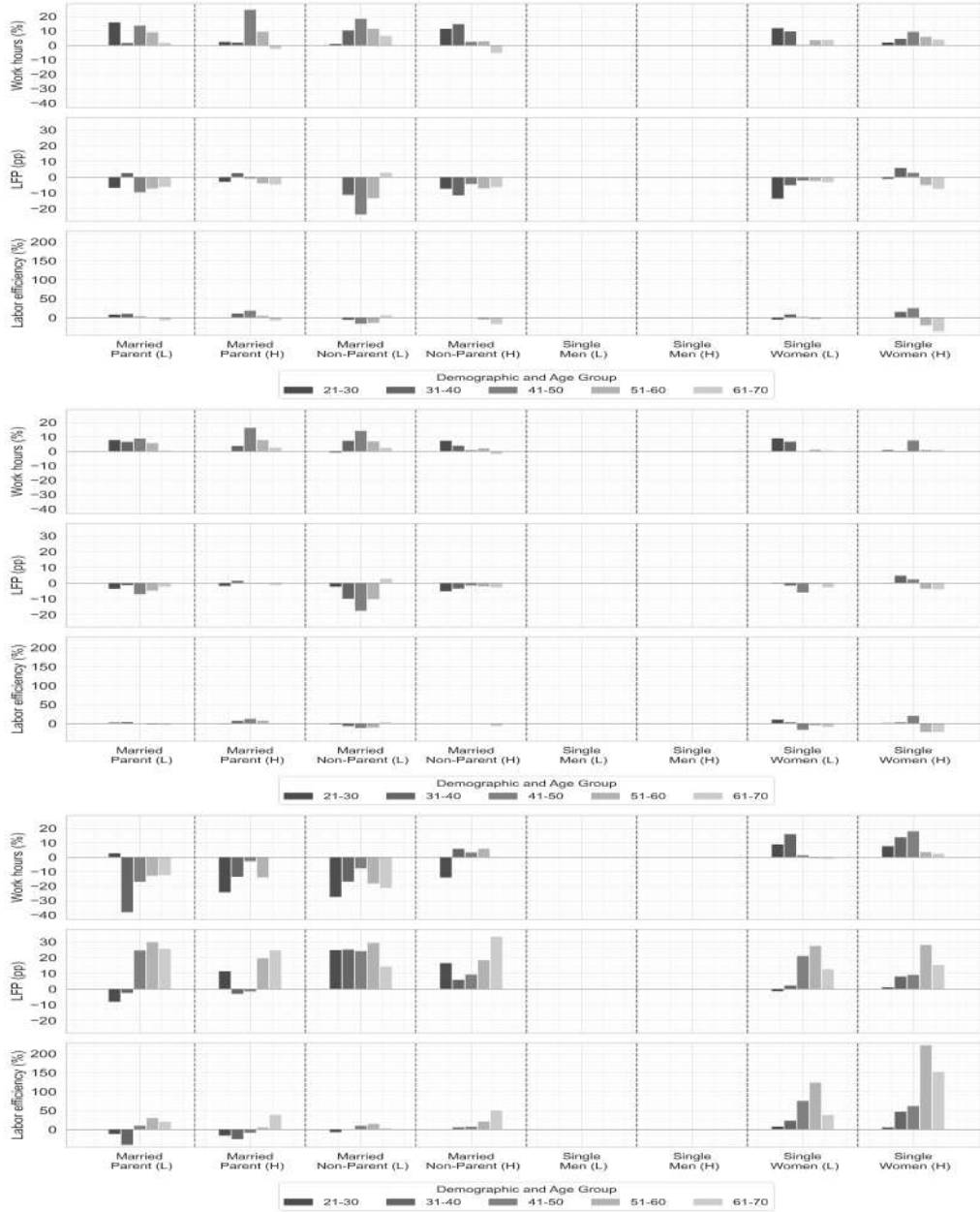


Figure 45: Changes in labor supply (**top row**: work hours, **middle row**: labor force participation, **bottom row**: labor efficiency) by age and demographic under the benchmark FTB and CCS for three tax progressivity levels. **Top panel**: Proportional ($\tau = 0$); **Middle panel**: Optimal progressivity ($\tau = 0.1$); **Bottom panel**: High progressivity ($\tau = 0.6$).

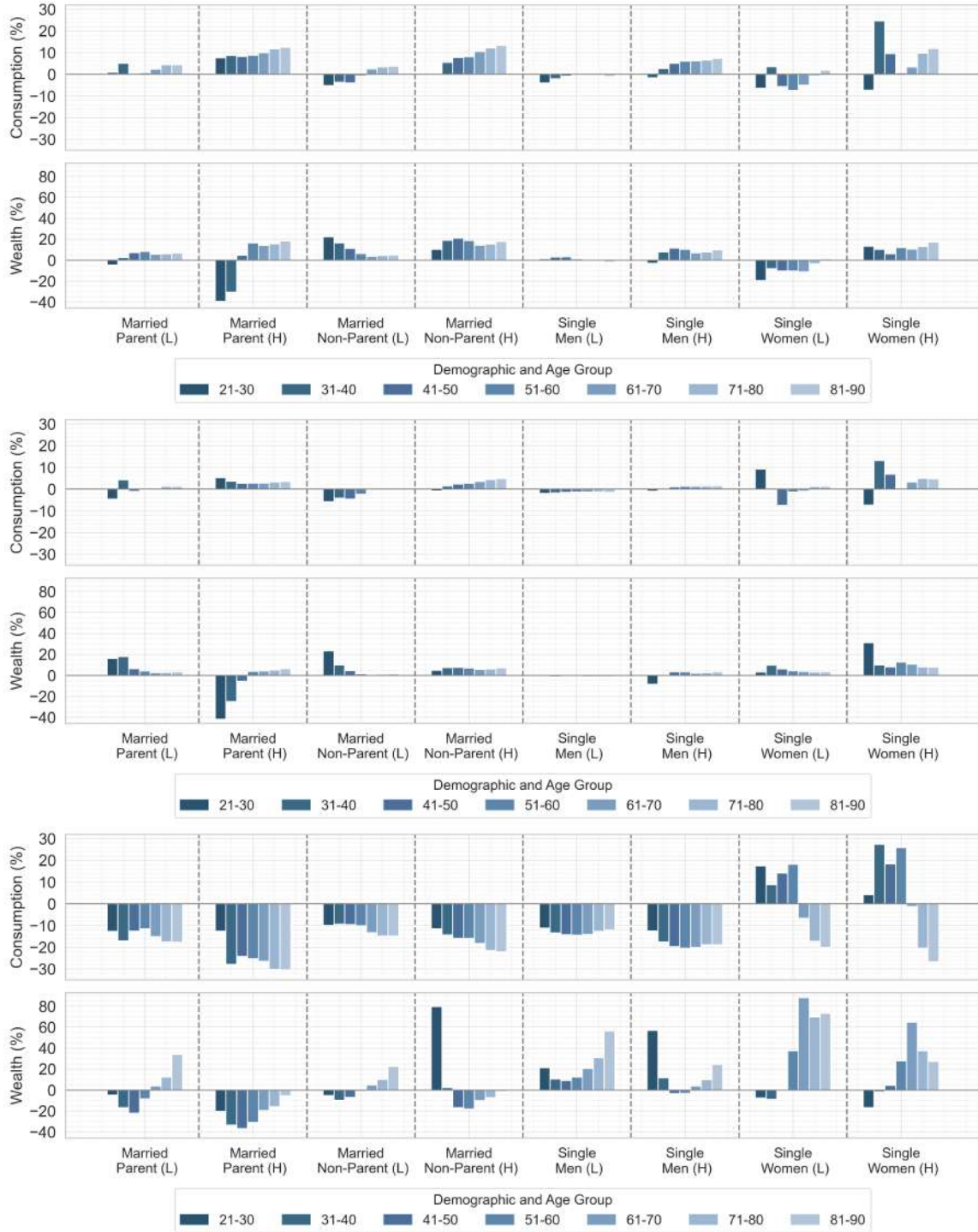


Figure 46: Changes in consumption and wealth (**top row**: consumption, **bottom row**: wealth) by age and demographic under the benchmark FTB and CCS for three tax progressivity levels. **Top panel**: Proportional ($\tau = 0$); **Middle panel**: Optimal progressivity ($\tau = 0.1$); **Bottom panel**: High progressivity ($\tau = 0.6$).

G.2 Optimal child benefits with benchmark tax progressivity

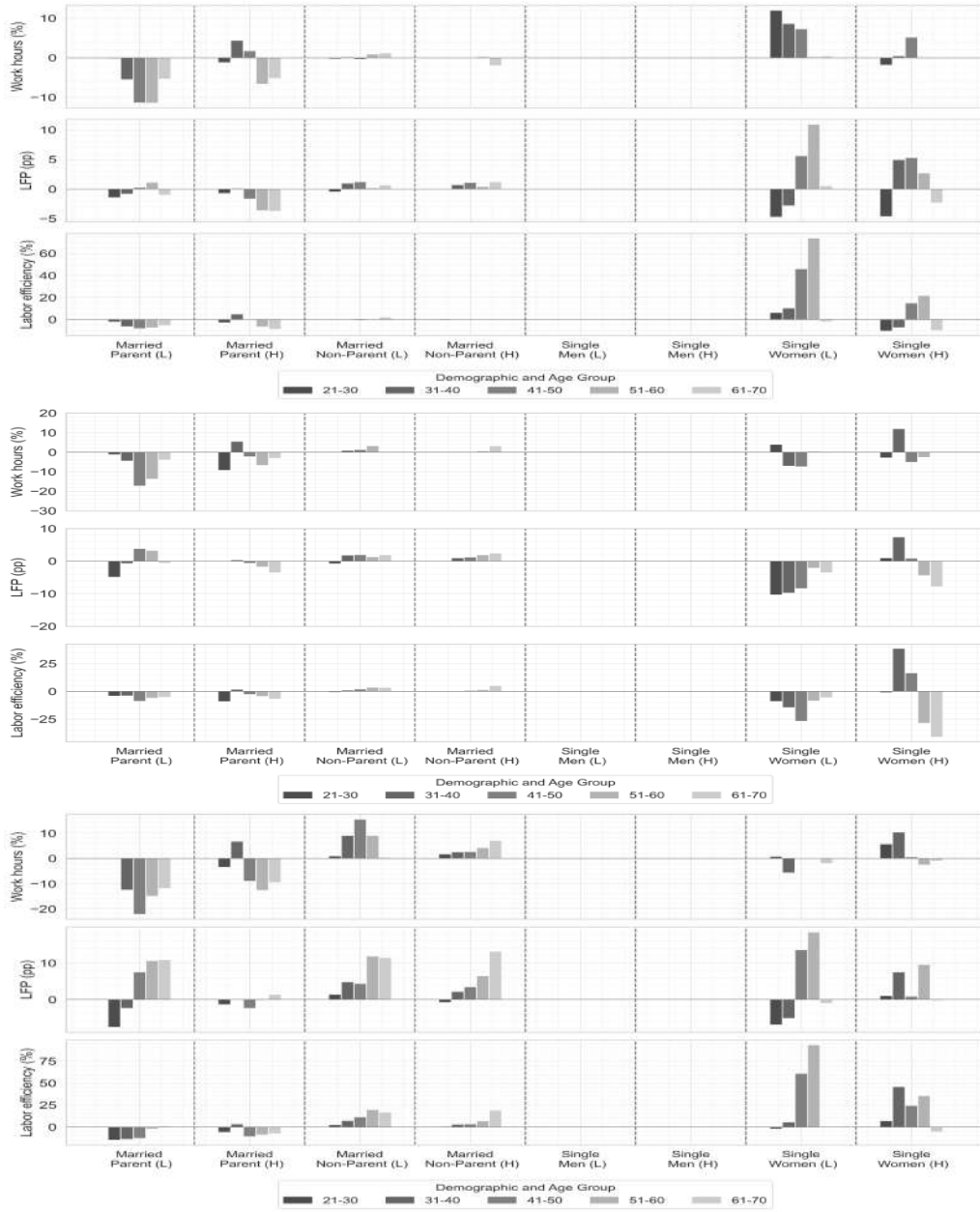


Figure 47: Changes in labor supply (**top row**: work hours, **middle row**: labor force participation, **bottom row**: labor efficiency) by age and demographic under the benchmark tax progressivity and universal child benefits at three payment rates. **Top panel**: $\bar{t}r = 15\%$; **Middle panel**: $\bar{t}r^* = 25\%$; **Bottom panel**: $\bar{t}r = 35\%$.

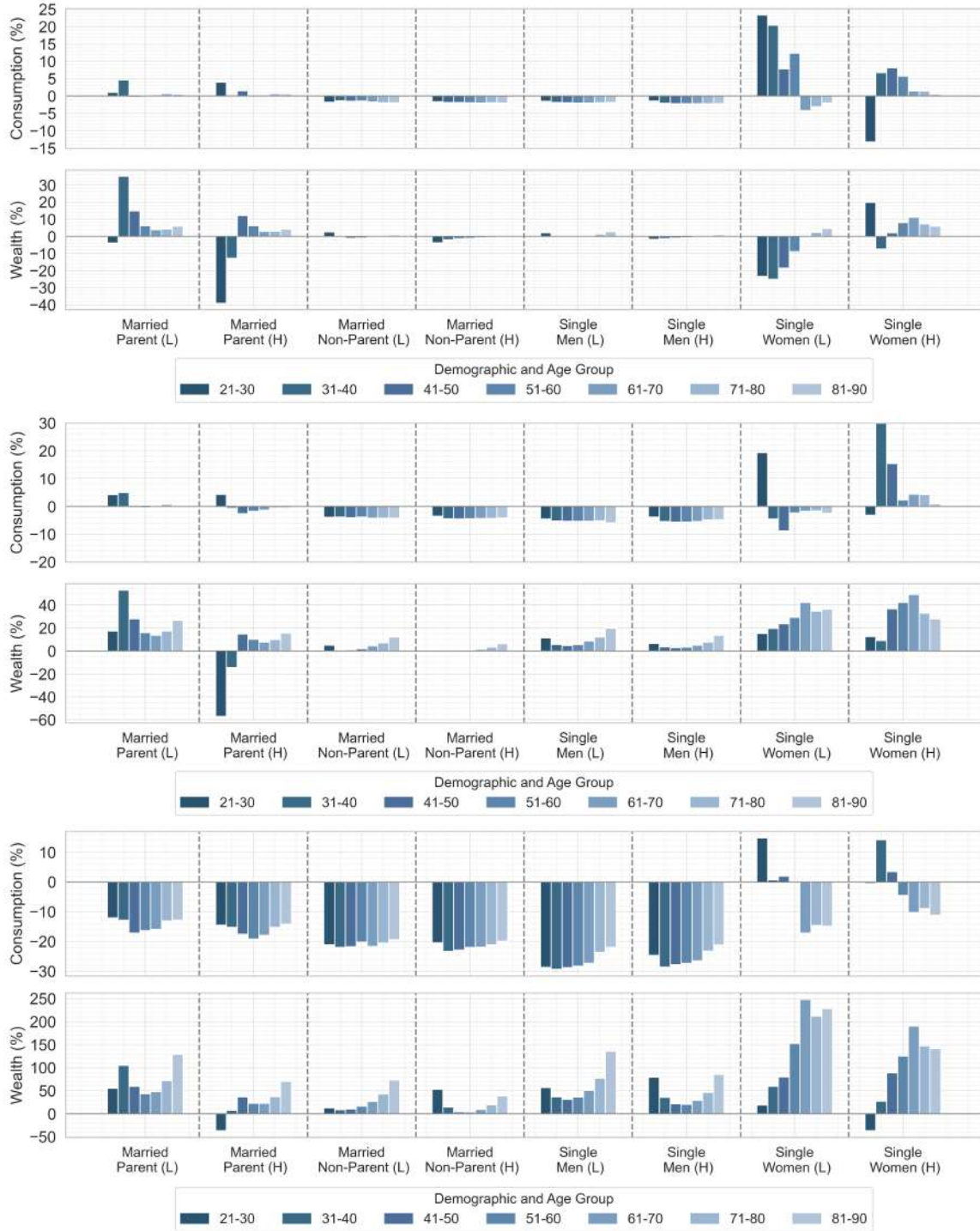


Figure 48: Changes in consumption and wealth (**top row**: consumption, **bottom row**: wealth) by age and demographic under the benchmark tax progressivity and universal child benefits at three payment rates. **Top panel**: $\bar{t}r = 15\%$; **Middle panel**: $\bar{t}r^* = 25\%$; **Bottom panel**: $\bar{t}r = 35\%$.

G.3 Removing CCS

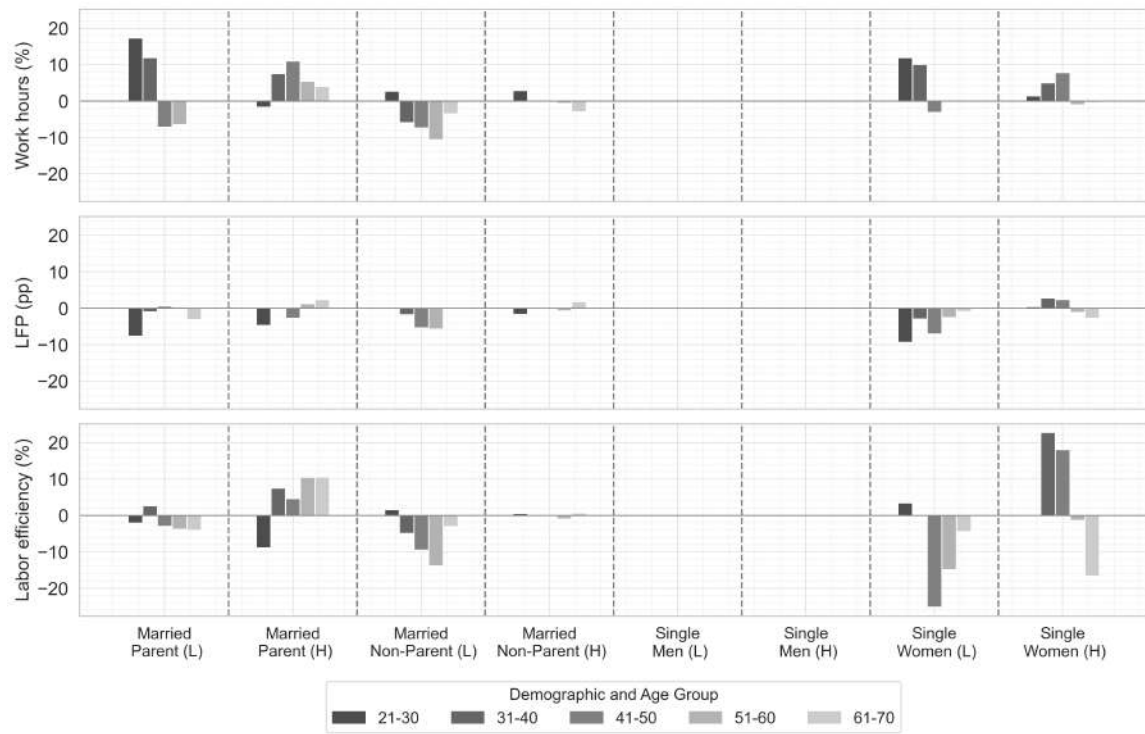


Figure 49: Changes in labor supply (**top**: work hours, **middle**: labor force participation, **bottom**: labor efficiency) by age and demographic in the absence of the child care subsidy (CCS).

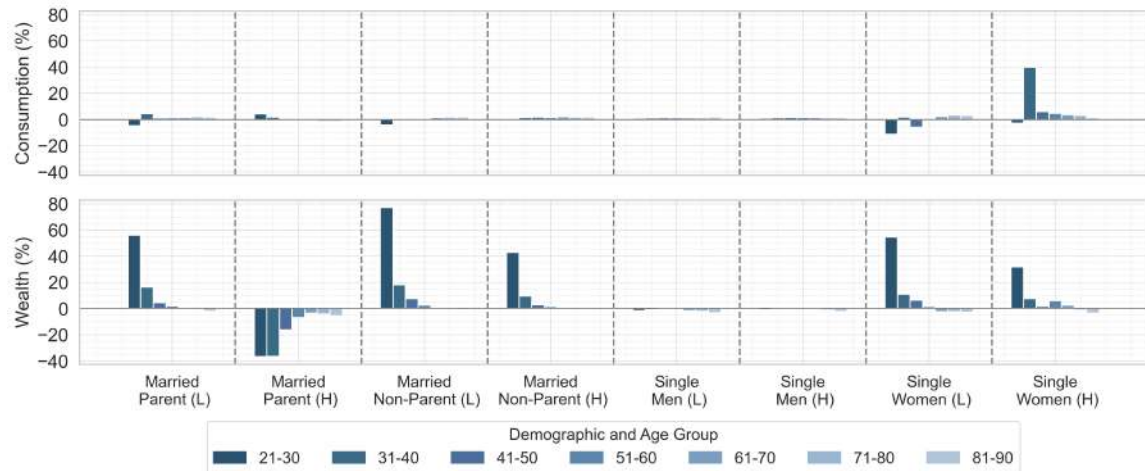


Figure 50: Changes in consumption and wealth (**top**: consumption, **bottom**: wealth) by age and demographic in the absence of the child care subsidy (CCS).

G.4 Removing FTB

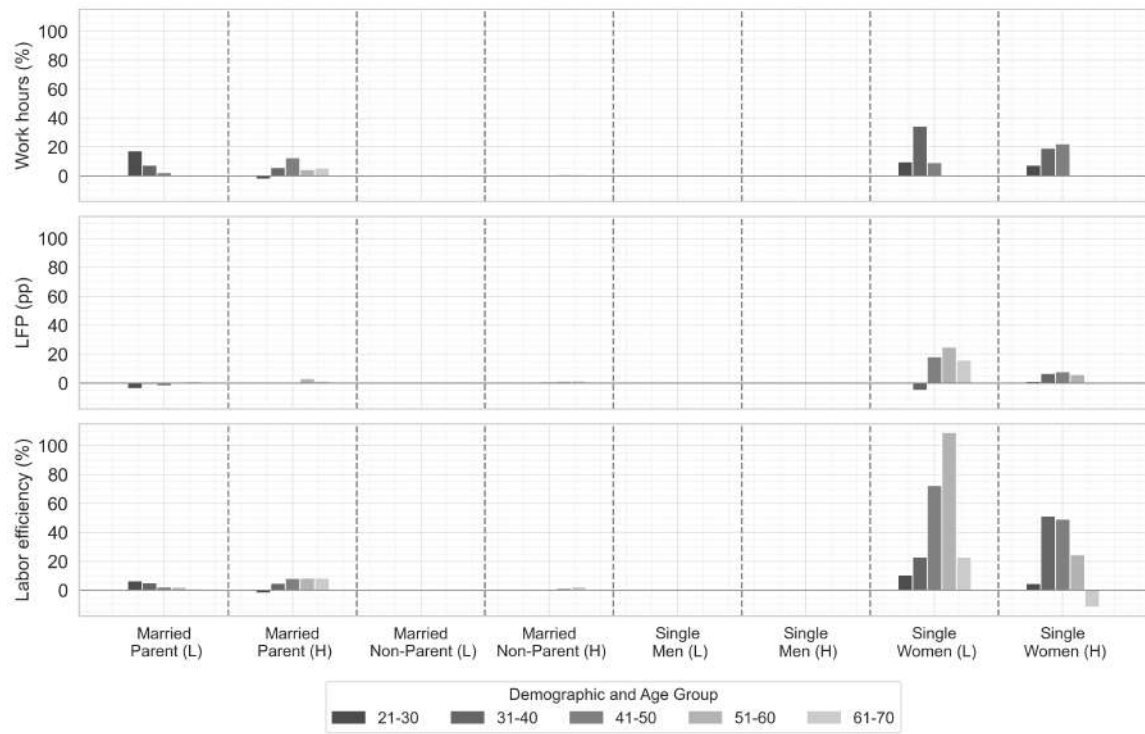


Figure 51: Changes in labor supply (**top**: work hours, **middle**: labor force participation, **bottom**: labor efficiency) by age and demographic in the absence of the Family Tax Benefit (FTB).

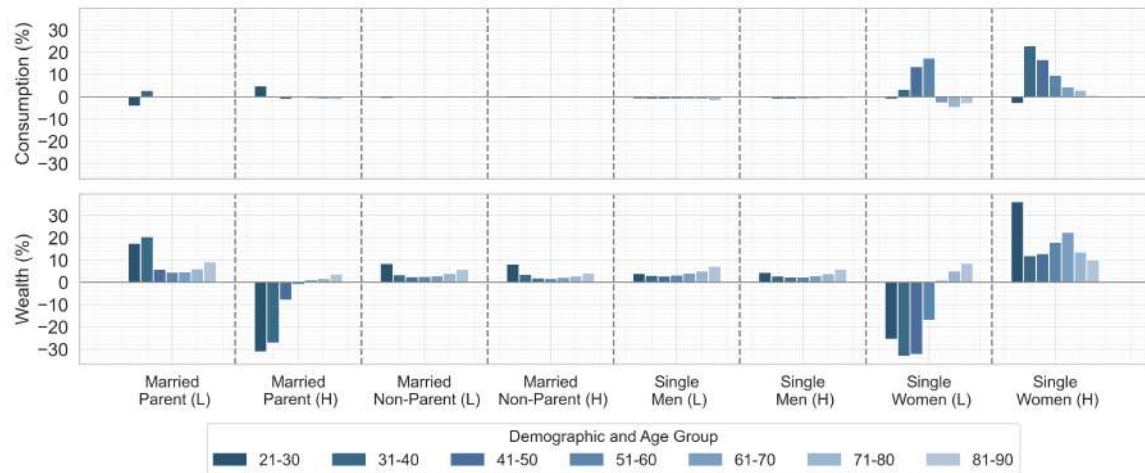


Figure 52: Changes in consumption and wealth (**top**: consumption, **bottom**: wealth) by age and demographic in the absence of the Family Tax Benefit (FTB).

G.5 Baseline universal child benefits

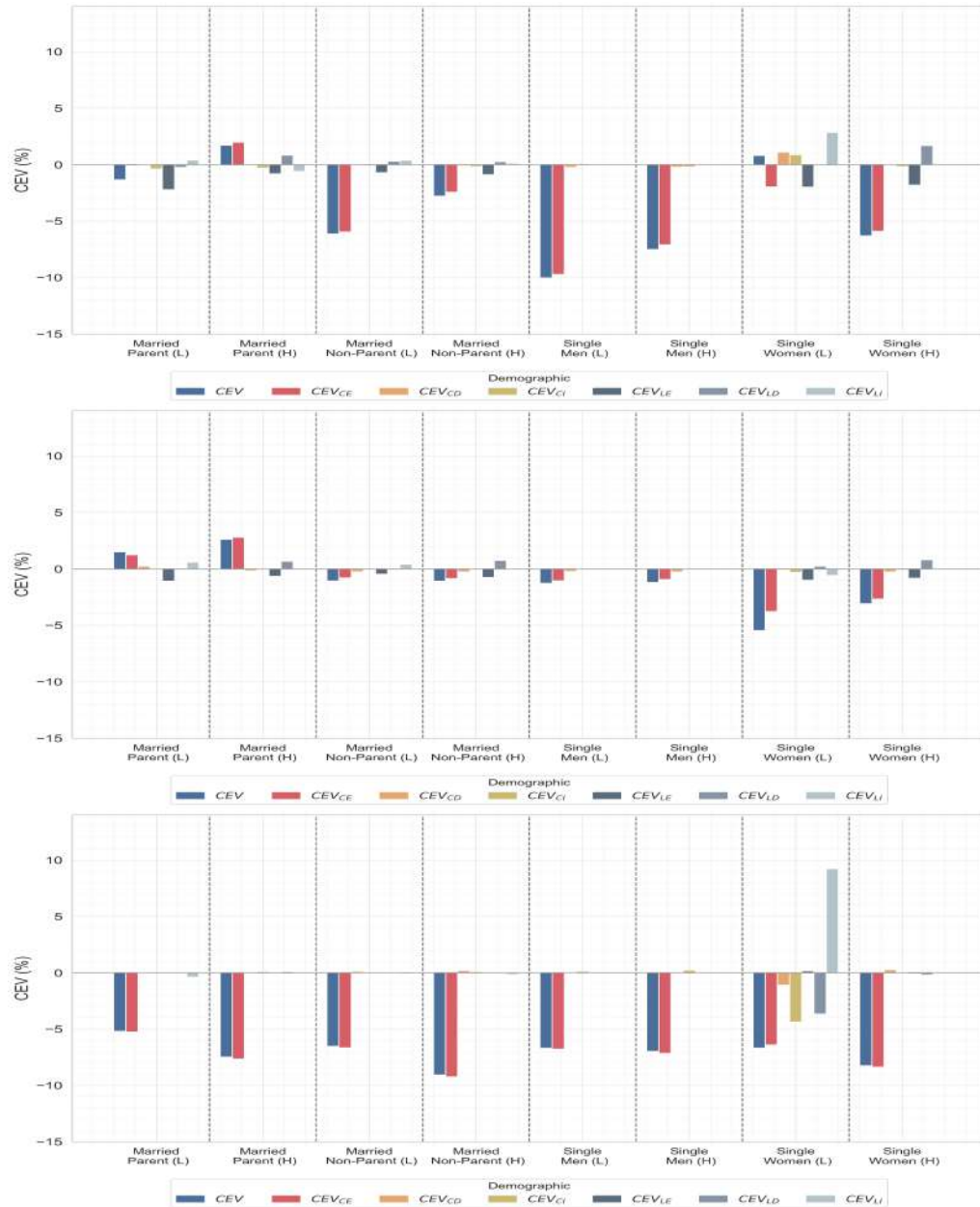


Figure 53: Decomposition of welfare changes by demographic under the baseline universal child benefits for three different tax progressivity levels. **Top panel:** Proportional ($\tau = 0$); **Middle panel:** Moderate progressivity, benchmark ($\tau = 0.2$); **Bottom panel:** High progressivity ($\tau = 0.5$) .

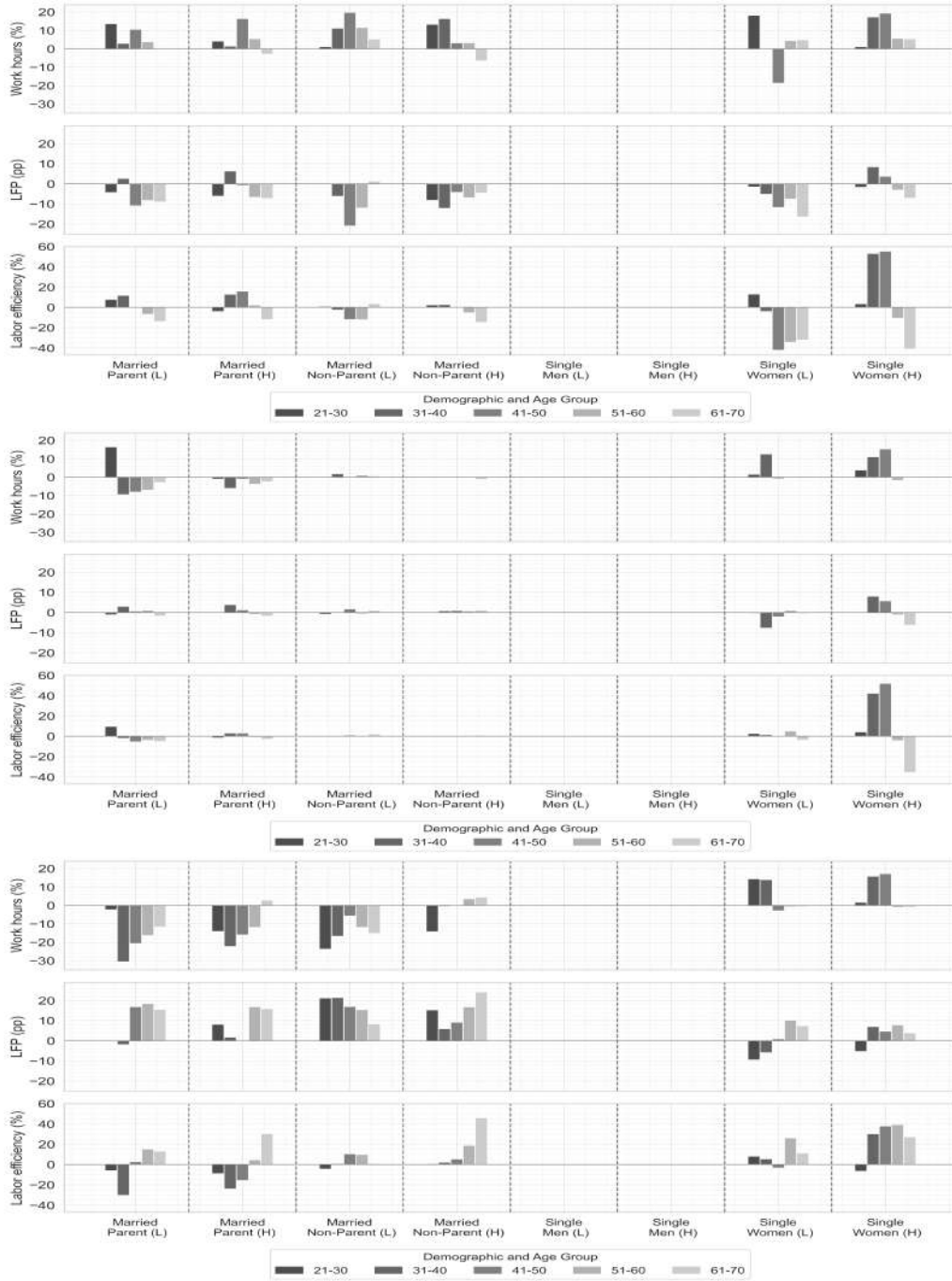


Figure 54: Changes in labor supply (**top row**: work hours, **middle row**: labor force participation, **bottom row**: labor efficiency) by age and demographic under the baseline universal child benefits for three tax progressivity levels. **Top panel**: Proportional ($\tau = 0$); **Middle panel**: Moderate progressivity, benchmark ($\tau = 0.2$); **Bottom panel**: High progressivity ($\tau = 0.5$).

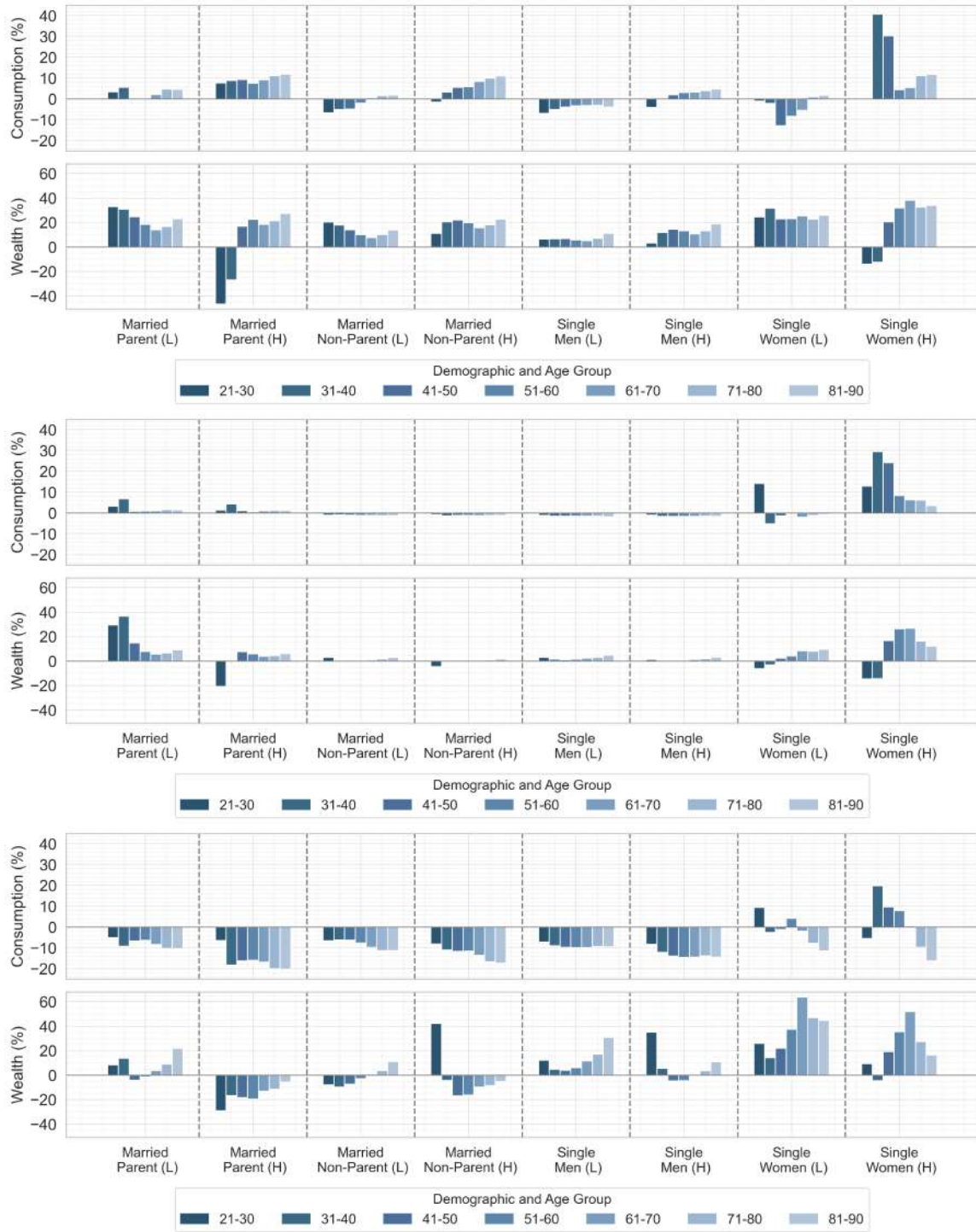


Figure 55: Changes in consumption and wealth (**top row**: consumption, **bottom row**: wealth) by age and demographic under the baseline universal child benefits for three different tax progressivity levels. **Top panel**: Proportional ($\tau = 0$); **Middle panel**: Moderate progressivity, benchmark ($\tau = 0.2$); **Bottom panel**: High progressivity ($\tau = 0.5$).

G.6 Additional results: Optimal tax progressivity and universal lump-sum child benefits per child

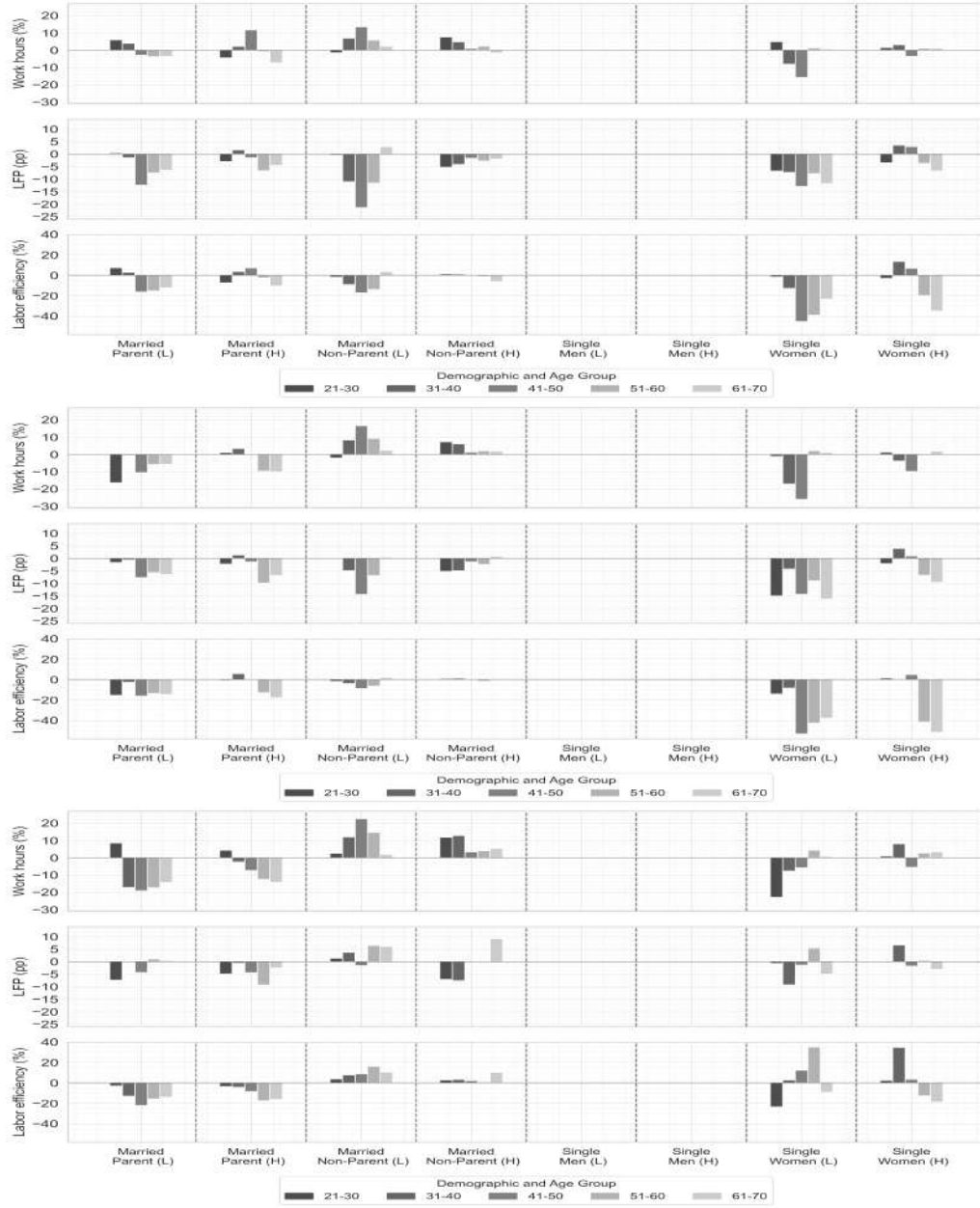


Figure 56: Changes in labor supply (**top row**: work hours, **middle row**: labor force participation, **bottom row**: labor efficiency) by age and demographic under the optimal tax progressivity ($\tau^* = 0.1$) and three different levels of universal lump-sum child benefits per child. **Top panel**: $\bar{t}r = 20\% \times \text{average income}$; **Middle panel**: optimal $\bar{t}r^* = 30\% \times \text{average income}$; **Bottom panel**: $\bar{t}r = 40\% \times \text{average income}$.

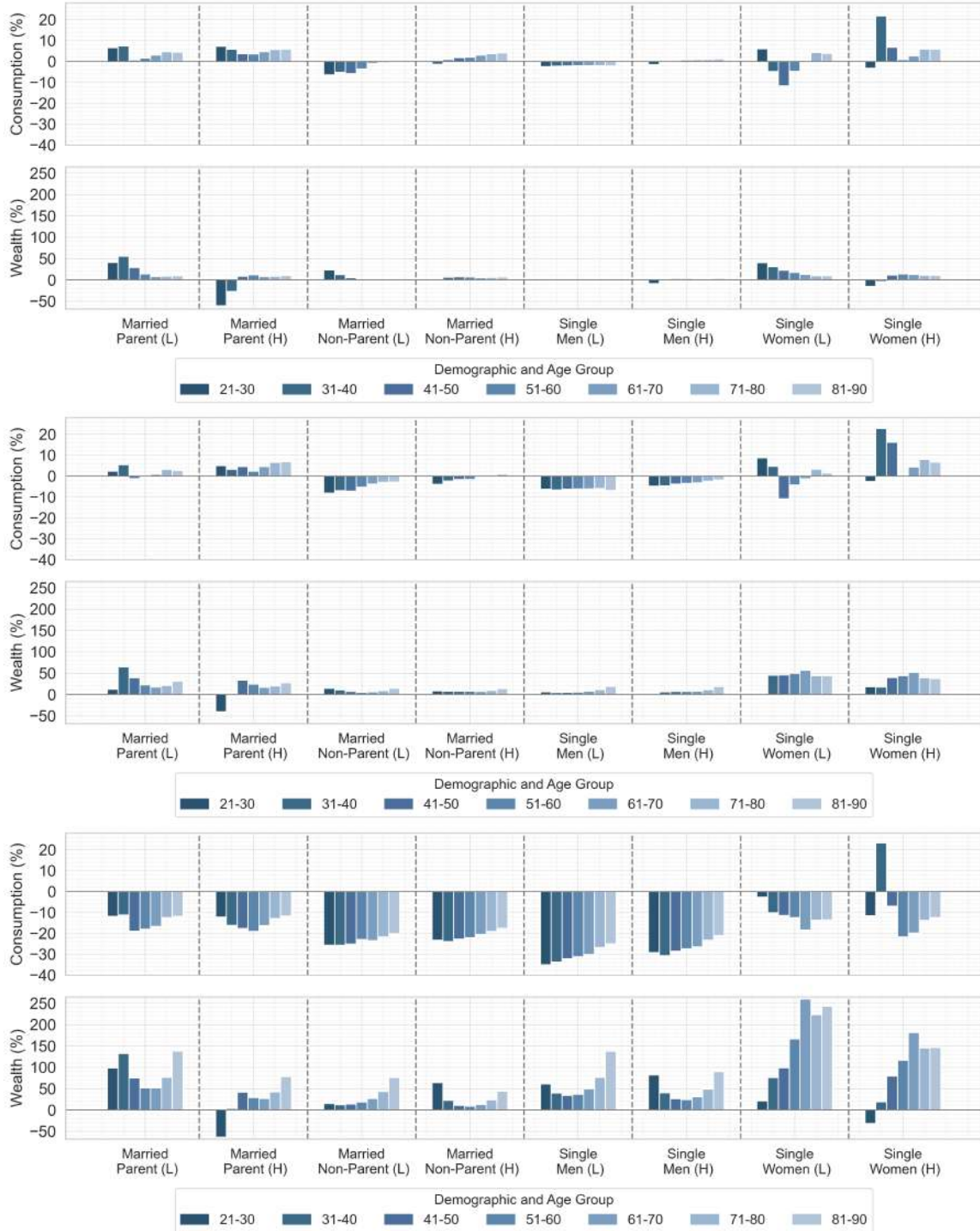


Figure 57: Changes in consumption and wealth (**top row**: consumption, **bottom row**: wealth) by age and demographic under the optimal tax progressivity ($\tau^* = 0.1$) and three different levels of universal lump-sum child benefits per child. **Top panel**: $\bar{t}r = 20\% \times \text{average income}$; **Middle panel**: optimal $\bar{t}r^* = 30\% \times \text{average income}$; **Bottom panel**: $\bar{t}r = 40\% \times \text{average income}$.

G.7 Supplementary figures: Female labor supply profiles

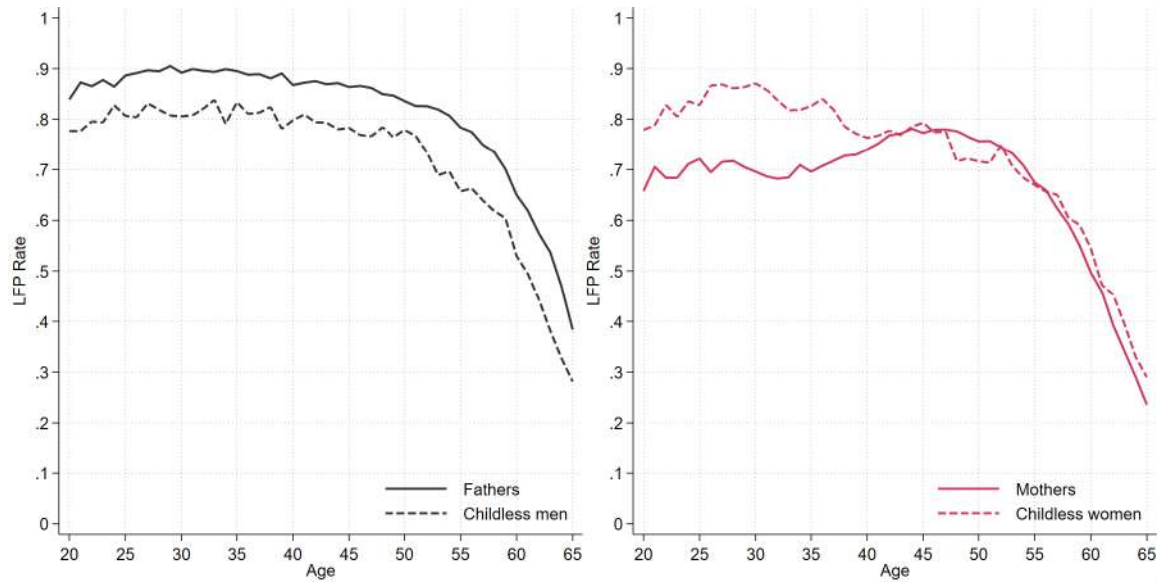


Figure 58: **Age profiles of labor force participation.** **Left:** fathers (solid) and childless men (dashed). **Right:** mothers (solid) and childless women (dashed).

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.

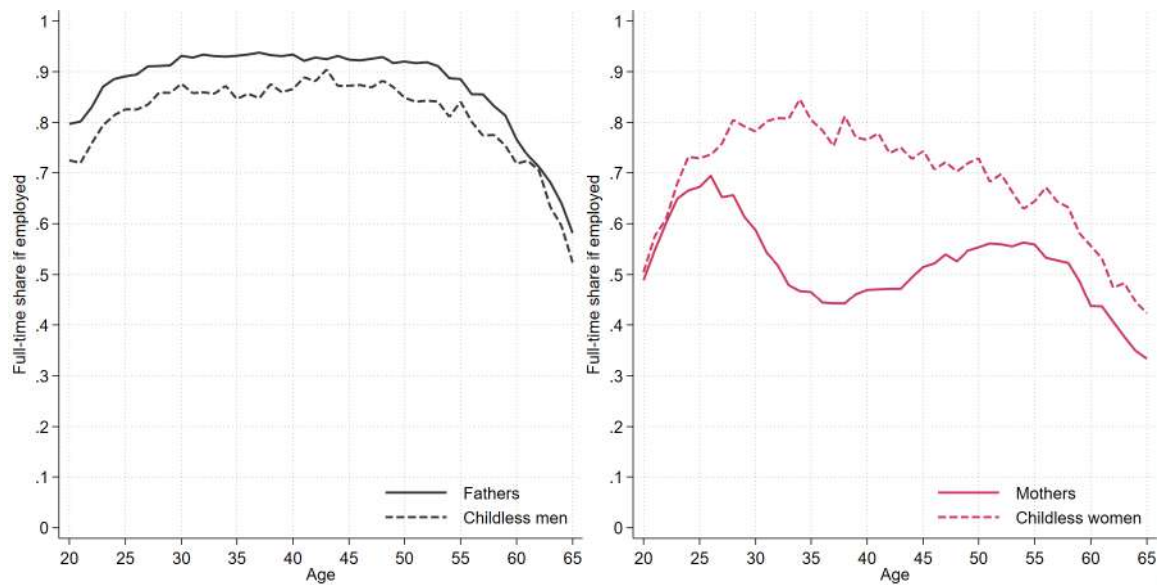


Figure 59: **Age profiles of full-time share of employment.** **Left:** fathers (solid) and childless men (dashed). **Right:** mothers (solid) and childless women (dashed).

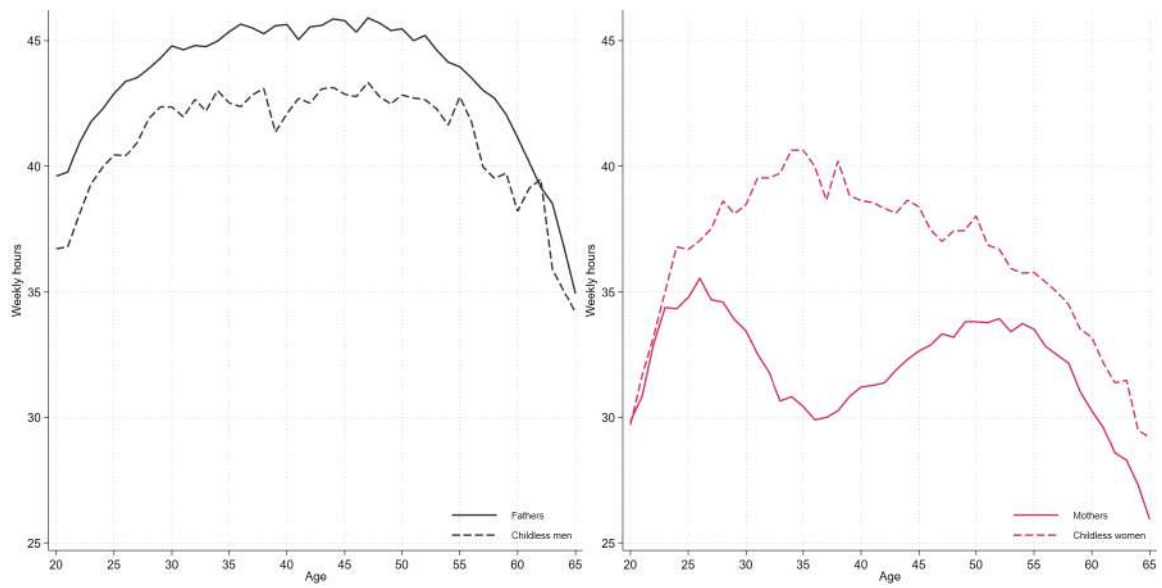


Figure 60: Intensive margin: Age profiles of work hours (if employed) by key demographics (gender and parenthood). Left: fathers (solid) and childless men (dashed). Right: mothers (solid) and childless women (dashed).

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.

H Welfare programs in Australia

H.1 Trends in welfare expenditure

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

Figure 61: **Welfare expenditure in Australia**

Notes: \$ value is expressed in 2019–20 AUD.

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

Figure 62: **Welfare expenditure to GDP (%) by target groups**

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

H.2 Child-related transfer programs in Australia

		2001-05	2006-10	2011-15	2016-20*	Total
Income support	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	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		0.26%	0.22%	0.10%	0.18%	0.18%

Table H.1: **Components of Australian public transfers over time**

Notes: *The welfare and social security transfers account for roughly 30% of government revenue in the 2016-20 period.

H.3 Family Tax Benefit part A (FTB-A)

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

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

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.

$$\begin{aligned}
 b_{A,j} = & LFS_j + NBS_j + MBA_j + CES_{A,base,j} \\
 & + ndep_{[0,17],j} \times FTBA_{base1} \\
 & + ndep_{[18,24],j} \times FTBA_{base2} \\
 & + \mathbf{1}_{\{school=1\}} ndep_{[18,19],j} \times FTBA_{base3} \\
 & + \mathbf{1}_{\{school=0\}} ndep_{[18,21],j} \times FTBA_{base4}
 \end{aligned} \tag{H.1}$$

$$\begin{aligned}
 m_{A,j} = & LFS_j + NBS_j + MBA_j + RA_j + CES_{A,max,j} \\
 & + ndep_{[0,12],j} \times FTBA_{max1} \\
 & + ndep_{[13,15],j} \times FTBA_{max2} \\
 & + ndep_{[16,17],j} \times FTBA_{max3} \\
 & + ndep_{[18,24],j} \times FTBA_{max4} \\
 & + \mathbf{1}_{\{school=1\}} ndep_{[16,19],j} \times FTBA_{max5} \\
 & + \mathbf{1}_{\{school=0\}} ndep_{[16,17],j} \times FTBA_{max6} \\
 & + ndep_{[18,21],j} \times FTBA_{max7}
 \end{aligned} \tag{H.2}$$

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 AUD.

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

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

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

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

We can then calculate the FTB-A benefit.

$$FTBA_j^0(y_h) = \begin{cases} m_{A,j} & \text{if } y_h \leq TH_{max} \\ MAX\{b_{A,j}, m_{A,j} - FTBA_{w1}(y_h - TH_{max})\} & \text{if } TH_{max} < y_h \leq TH_{base} \\ MAX\{0, m_{A,j} - FTBA_{w1}(y_h - TH_{max}), b_{A,j} - FTBA_{w2}(y_h - TH_{base})\} & \text{if } y_h > TH_{base} \end{cases} \tag{H.4}$$

where the total household taxable income $y_h = y_m + y_f + ra$ 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

$$FTBA_j(y_h) = \begin{cases} MAX\{0, FTBA_j^0(y_h) - FTBA_{AS} \times (ndep_{[0,12],j} + ndep_{[13,15],j} + \mathbf{1}_{\{school=1\}} ndep_{[16,19],j})\} & \text{if } y_h > FTBA_{FT1} \\ FTBA_j^0(y_h) & \text{otherwise} \end{cases} \tag{H.5}$$

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 AUD.

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):

$$LFS_j = \min\{FTBA_{S1} \times (ndep_{[0,24],j} - FTBA_{C1} + 1), 0\} \quad (H.6)$$

where $ndep_{[a,b],j}$ denotes the number of children in the age range $[a,b]$ of parents aged j , $FTBA_{S1}$ is the LFS amount per child, and $FTBA_{C1}$ is the number of dependent children a family must have to be eligible for the LFS for the first child to satisfy the cutoff $FTBA_{C1}$ and every additional child onward. In 2018, $FTBA_{C1} = 1$ and $FTBA_{S1} = 0$.

Newborn Supplement (NBS):

$$NBS_j = \begin{cases} \mathbf{1}_{\{nb_j \geq 1, fc_j = 1\}} FTBA_{NS1} \times nb_j + \mathbf{1}_{\{nb_j \geq 1, fc_j = 0\}} FTBA_{NS2} \times nb_j & \text{if } ppl = 0 \\ \mathbf{1}_{\{nb_j \geq 2, fc_j = 1\}} FTBA_{NS1} \times (nb_j - 1) + \mathbf{1}_{\{nb_j \geq 2, fc_j = 0\}} FTBA_{NS2} \times (nb_j - 1) & \text{if } ppl = 1 \end{cases} \quad (H.7)$$

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 AUD.

Multiple Birth Allowance (MBA):

$$MBA_j = \begin{cases} \mathbf{1}_{\{sa=3, j_c \leq FTBA_{MAGES}\}} FTBA_{MBA1} + \mathbf{1}_{\{sa \geq 4, j_c \leq FTBA_{MAGES}\}} FTBA_{MBA2} & \text{if } school = 1 \\ \mathbf{1}_{\{sa=3, j_c \leq FTBA_{MAGE}\}} FTBA_{MBA1} + \mathbf{1}_{\{sa \geq 4, j_c \leq FTBA_{MAGE}\}} FTBA_{MBA2} & \text{if } school = 0 \end{cases} \quad (H.8)$$

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 AUD.

Clean Energy Supplement for the FTB part A (CES_A):

The Clean Energy Supplement for the FTB part A (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.

$$\begin{aligned} CES_{A,base,j} &= ndep_{[0,17],j} \times FTBA_{CE1} + ndep_{[18,19]_{AS},j} \times FTBA_{CE1} \\ CES_{A,max,j} &= ndep_{[0,12],j} \times FTBA_{CE2} + ndep_{[13,15],j} \times FTBA_{CE3} + ndep_{[16,19]_{AS},j} \times FTBA_{CE3} \end{aligned} \quad (H.9)$$

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 AUD.

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.

$$RA_j(rent) = \begin{cases} \max\{\min\{0.75(rent - rent_{min}), RA_{max}\}, 0\} & \text{if } FTBA_1 \geq FTBA_{min} \\ 0 & \text{otherwise} \end{cases} \quad (H.10)$$

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. In 2018, expressed in 2018 AUD

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

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

Before 2013, $FTBA_{min}$ is set to the base FTB-A payment and $FTBA_{min} = 0$ thereafter.

H.4 Family Tax Benefit part B (FTB-B)

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

Let $y_{pe} = \text{MAX}(y_m, y_f)$ and $y_{se} = \text{MIN}(y_m, y_f)$ denote the primary earner's and secondary earner's taxable income, respectively, and let $m_{B_i,j} = \text{FTBB}_{max_i} + \text{CES}_B$ 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 onwards.

Before 2017:

$$\text{FTBB}_j(y_m, y_f) =$$

$$\begin{cases} \text{cond}_1 \times m_{B_1,j} + \text{cond}_2 \times m_{B_2,j} & \text{if } y_{pe} \leq \text{FTBB}_{T_1} \text{ and } y_{se} \leq \text{FTBB}_{T_2} \\ \text{cond}_1 \times \text{MAX}\{0, m_{B_1,j} - \text{FTBB}_w(y_{se} - \text{FTBB}_{T_2})\} & \text{if } y_{pe} \leq \text{FTBB}_{T_1} \text{ and } y_{se} > \text{FTBB}_{T_2} \\ + \text{cond}_2 \times \text{MAX}\{0, m_{B_2,j} - \text{FTBB}_w(y_{se} - \text{FTBB}_{T_2})\} & \end{cases} \quad (\text{H.11})$$

From 2017:

$$\text{FTBB}_j(y_m, y_f) =$$

$$\begin{cases} \text{cond}_1 \times m_{B_1,j} + \text{cond}_3 \times m_{B_2,j} & \text{if } y_{pe} \leq \text{FTBB}_{T_1} \text{ and } y_{se} \leq \text{FTBB}_{T_2} \\ \text{cond}_1 \times \text{MAX}\{0, m_{B_1,j} - \text{FTBB}_w(y_{se} - \text{FTBB}_{T_2})\} & \text{if } y_{pe} \leq \text{FTBB}_{T_1} \text{ and } y_{se} > \text{FTBB}_{T_2} \\ + \text{cond}_3 \times \text{MAX}\{0, m_{B_2,j} - \text{FTBB}_w(y_{se} - \text{FTBB}_{T_2})\} & \end{cases} \quad (\text{H.12})$$

where $\text{cond}_1 = 1_{\{\text{ndep}_{[0,4],j} \geq 1\}}$, $\text{cond}_2 = 1_{\{\text{ndep}_{[0,4],j}=0, (\text{ndep}_{[5,15],j} \geq 1 \text{ or } \text{ndep}_{[16,18]_{AS},j} \geq 1)\}}$ and $\text{cond}_3 = 1_{\{\text{ndep}_{[0,4],j}=0, \text{ndep}_{[5,12],j} \geq 1\}} + 1_{\{\text{ndep}_{[0,4],j}=0, \text{ndep}_{[5,12],j}=0, (\text{ndep}_{[13,15],j} \geq 1 \text{ or } \text{ndep}_{[16,18]_{AS},j} \geq 1), \text{single}=1\}}$

In 2018, the statutory maximum FTB-B payment $\text{FTBB}_{max} = \{4, 412.85; 3, 190.10\}$, the income test thresholds $\text{FTBB}_T = \{100,000; 5,548\}$ in 2018 AUD, and the withdrawal rate $\text{FTBB}_w = 0.20$.

Clean Energy Supplement for the FTB part B (CES_B):

The Clean Energy Supplement for FTB part B (CES_B) adds to the statutory per family payment of the FTB-B benefit.

$$\text{CES}_{B,j} = \begin{cases} \text{FTBB}_{CE_1} & \text{if } \text{ndep}_{[0,4],j} \geq 1 \\ \text{FTBB}_{CE_2} & \text{if } \text{ndep}_{[0,4],j} = 0 \text{ and } (\text{ndep}_{[5,15],j} \geq 1 \text{ or } \text{ndep}_{[16,18]_{AS},j} \geq 1) \\ 0 & \text{if } \text{ndep}_{[0,4],j} = 0 \text{ and } \text{ndep}_{[5,15],j} = 0 \text{ and } \text{ndep}_{[16,18]_{AS},j} = 0 \end{cases} \quad (\text{H.13})$$

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

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.

H.5 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_h), (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^m, n_j^f). 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,
3. Households exhaust all the available hours of subsidized care.

The child care subsidy function is

$$CCS(y_h, n_j^m, n_j^f) = \Psi(y_h, n_j^m, n_j^f) \times \begin{cases} CCS_{R_1} & \text{if } y_h \leq TH_1 \\ \text{MAX}\{CCS_{R_2}, CCS_{R_1} - \omega_1\} & \text{if } TH_1 < y_h < TH_2 \\ CCS_{R_2} & \text{if } TH_2 \leq y_h < TH_3 \\ \text{MAX}\{CCS_{R_3}, CCS_{R_2} - \omega_3\} & \text{if } TH_3 \leq y_h < TH_4 \\ CCS_{R_3} & \text{if } TH_4 \leq y_h < TH_5 \\ CCS_{R_4} & \text{if } y_h \geq TH_5 \end{cases} \quad (\text{H.14})$$

where $y_h = y_m + y_f + ra$ and $\omega_i = \frac{y_h - TH_i}{\text{taper unit}}$.

In 2018,

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

$$\Psi(y_h, n_j^m, n_j^f) = 0.24_{\{y_h \leq AU\$70,015, n_j^{min} \leq 8\}} + 0.36_{\{8 < n_j^{min} \leq 16\}} + 0.72_{\{16 < n_j^{min} \leq 48\}} + 1_{\{n_j^{min} > 48\}}$$

Otherwise, $\Psi(y_h, n_j^m, n_j^f) = 0$.

I Supplementary facts on child benefit programs

I.1 Child care benefit: Intensive and extensive margins

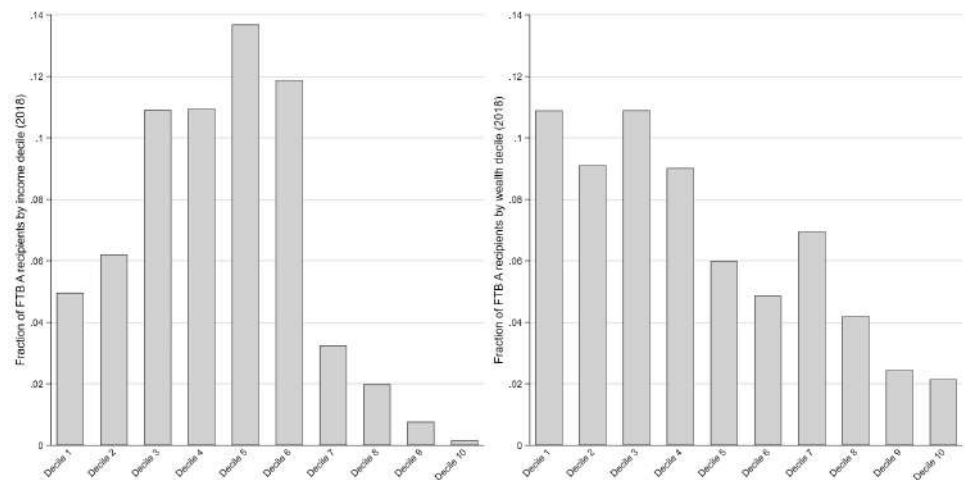


Figure I.1: FTB-A recipients in 2018. **Left:** By income decile, **Right:** By wealth decile

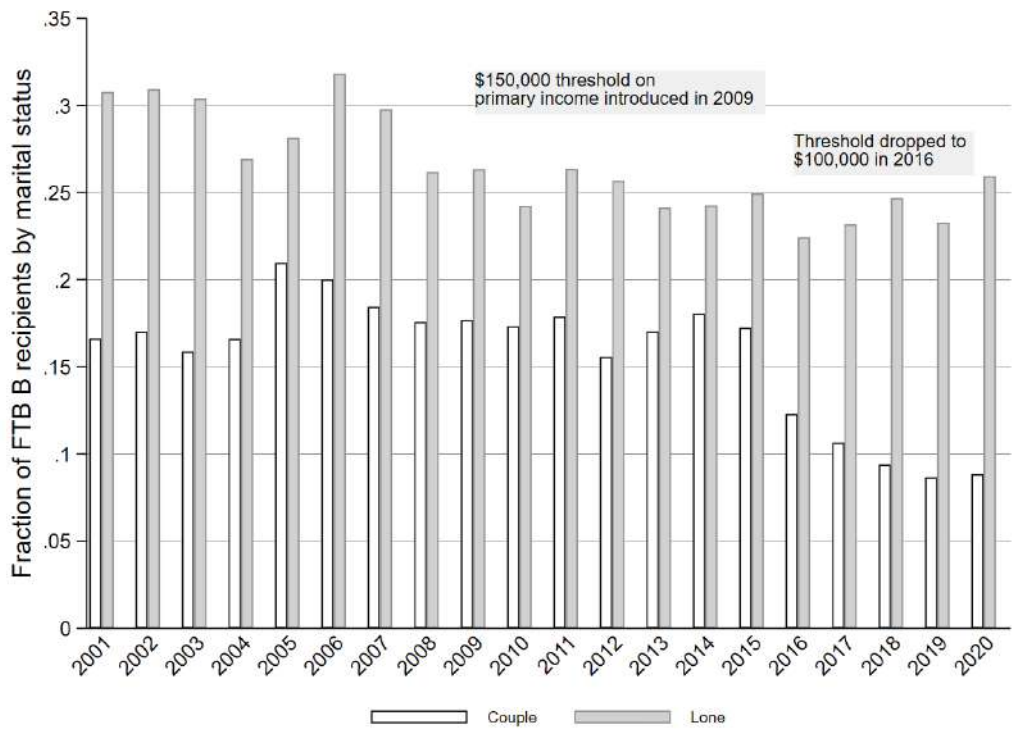


Figure I.2: Proportion of FTB-B recipients by marital status.

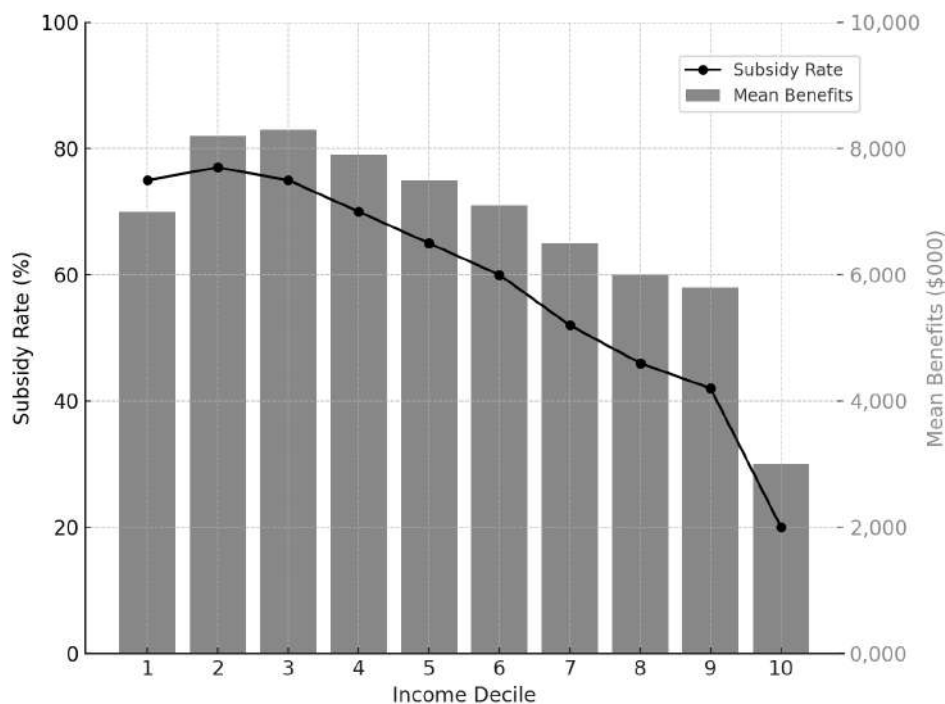


Figure I.3: Child Care Subsidy rates and Mean Benefits (Subsidies) by income decile.

Notes: This figure uses data from Table 61 in the 2021 report by the AIFS. The lowest decile earned at most \$31,399. The top decile earned \$240,818 or more.

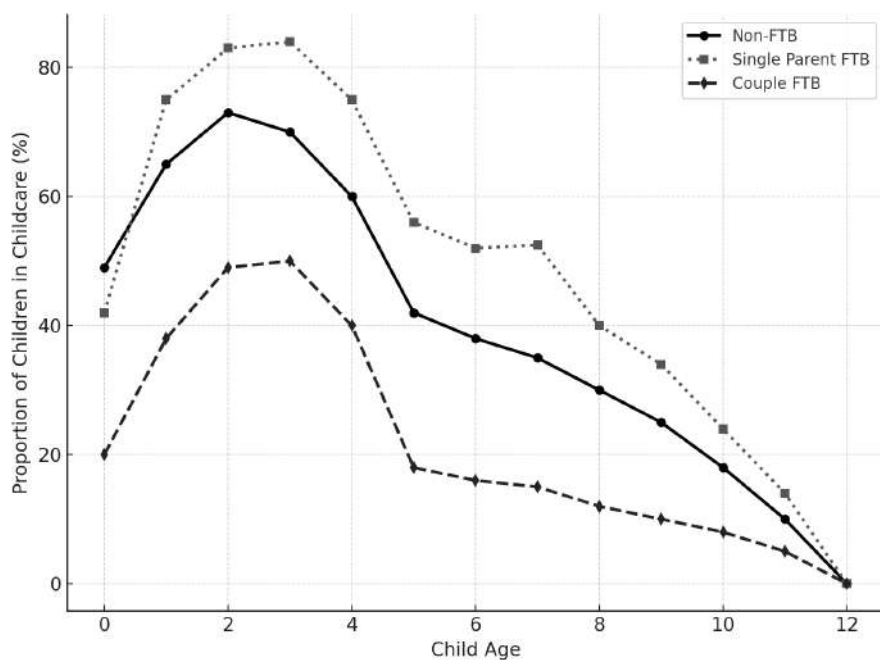


Figure I.4: Proportion of children in child care by child age and FTB receipt.

Notes: This figure uses data from Figure 95 in the 2021 report by the AIFS.

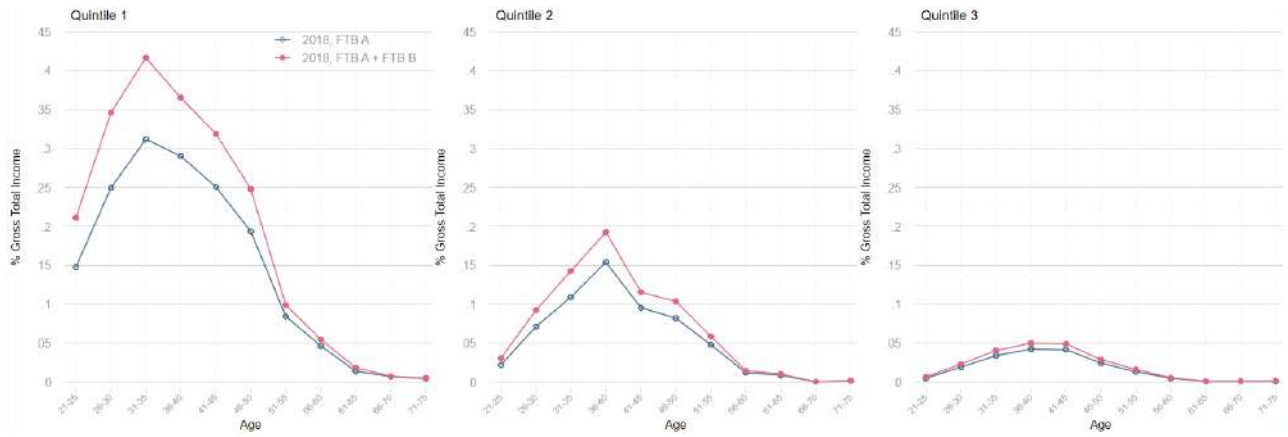


Figure I.5: Age profiles of FTB share of gross household income for the first three quintiles by family market income in 2018.

I.2 Supplementary figures: FTB-A parameters and related statistics

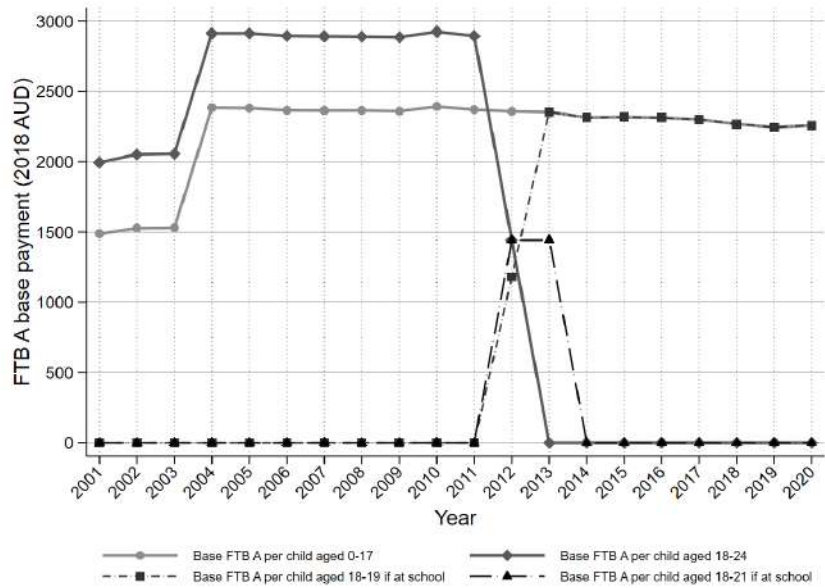


Figure I.6: FTB-A base payment rates per child

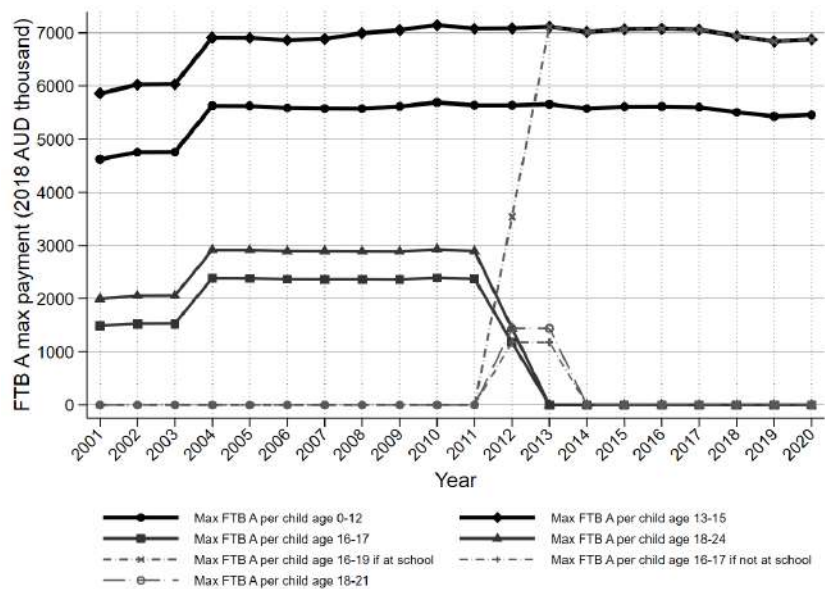


Figure I.7: FTB-A maximum payment rates per child

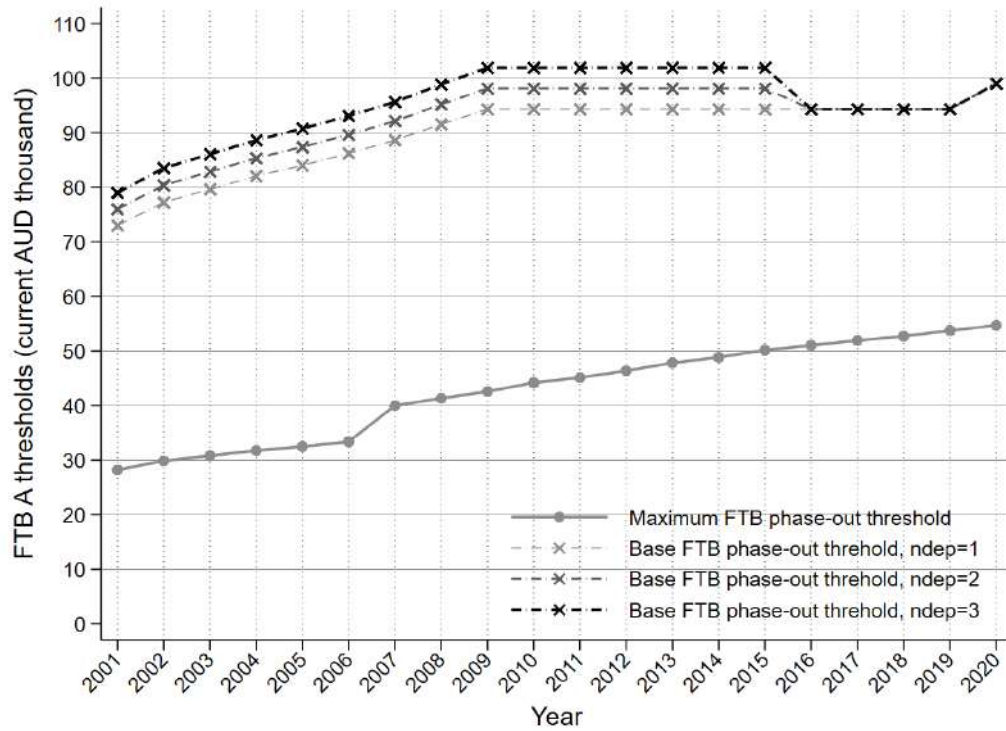


Figure I.8: FTB-A income test thresholds for maximum and base payment rates

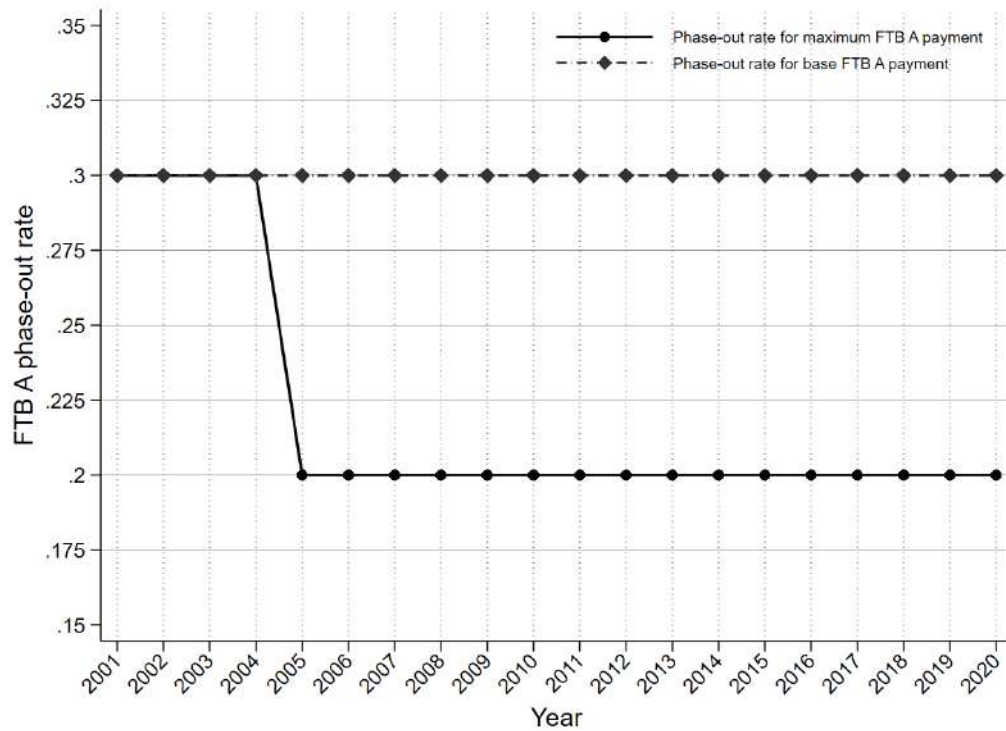


Figure I.9: FTB-A phase-out rates for maximum and base payments

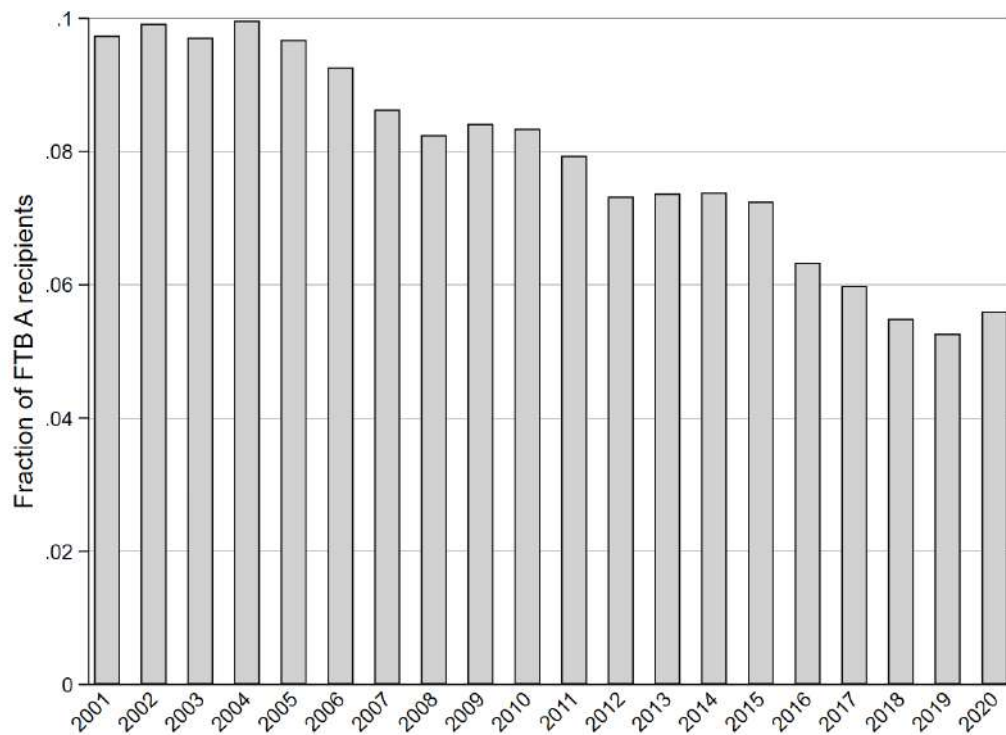


Figure I.10: Proportion of FTB-A recipients over time.

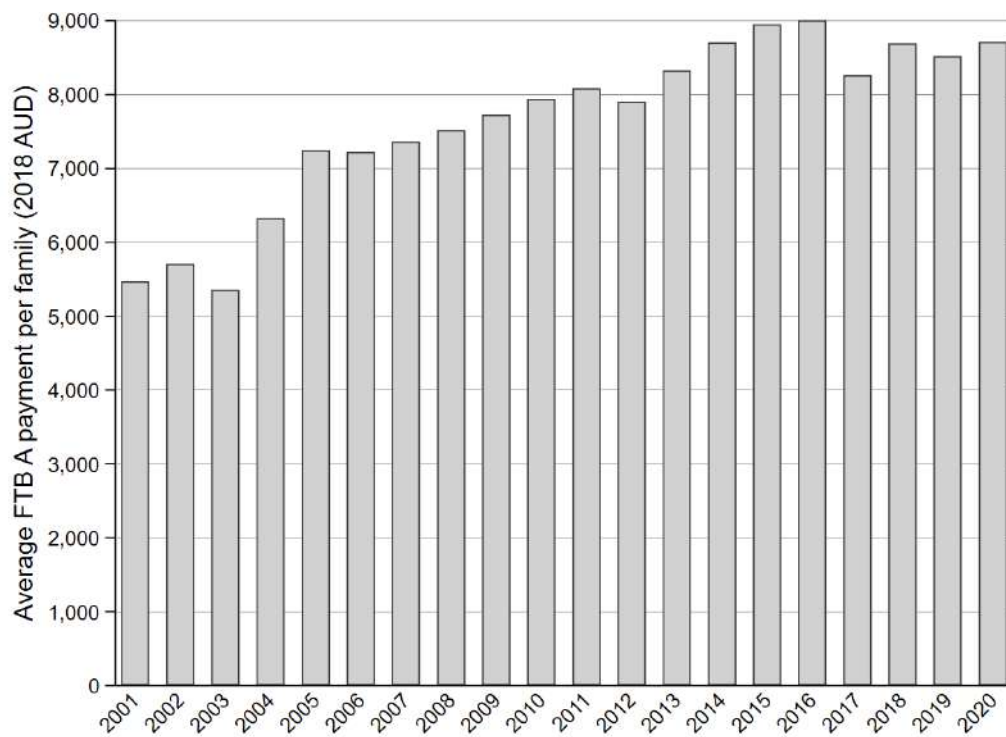


Figure I.11: Average FTB-A payment per family (2018 AUD) over time.

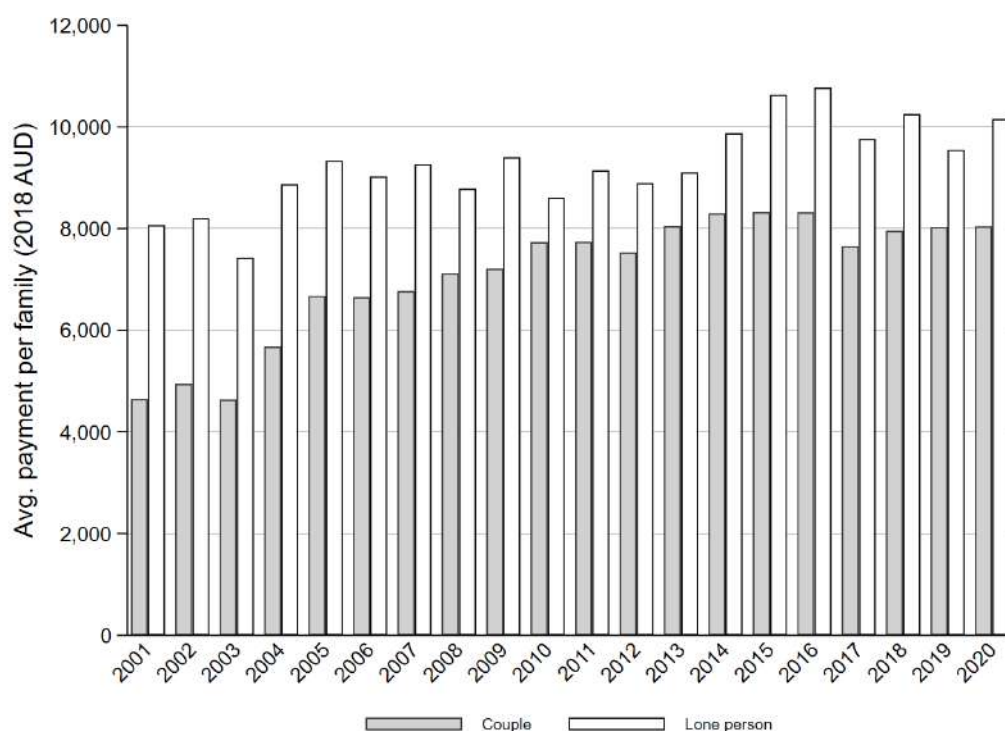


Figure I.12: Average FTB-A payment per family by marital status

The proportion of households receiving the FTB-A (out of all households observed in the survey data) has fallen from 10% in 2001 to slightly over 5% in 2020, (see Figure I.10). This can be attributed, in part, to threshold-creep (inflation pushing incomes above the income-test threshold) and the falling birth rate. Despite the overall decline, the benefit remains concentrated among low-income families.

At the intensive margin, the FTB-A alone represents a significant sum of inflation-indexed transfers. Figures I.6 and I.7 illustrate that there have been minimal changes to the base and maximum statutory payment rates for children under 18 since 2004. Qualified families with a child aged 13-15 could receive up to \$7,000. The maximum rate per dependent child aged 12 or younger is slightly lower, but still exceeds \$5,500. Given that payments are allocated per child, a two-children family could receive up to \$14,000. Moreover, Figure I.11 shows that the benefits delivered to eligible families have been rising. The average FTB-A payout increased from \$8,000 to \$8,500 over the past decade. Moreover, because the scheme predominantly targets single-earner families, especially single parents, single parent households claimed higher benefits on average compared to couple parent households, as seen in Figure I.12.

I.3 Supplementary figures: FTB-B parameters and related statistics

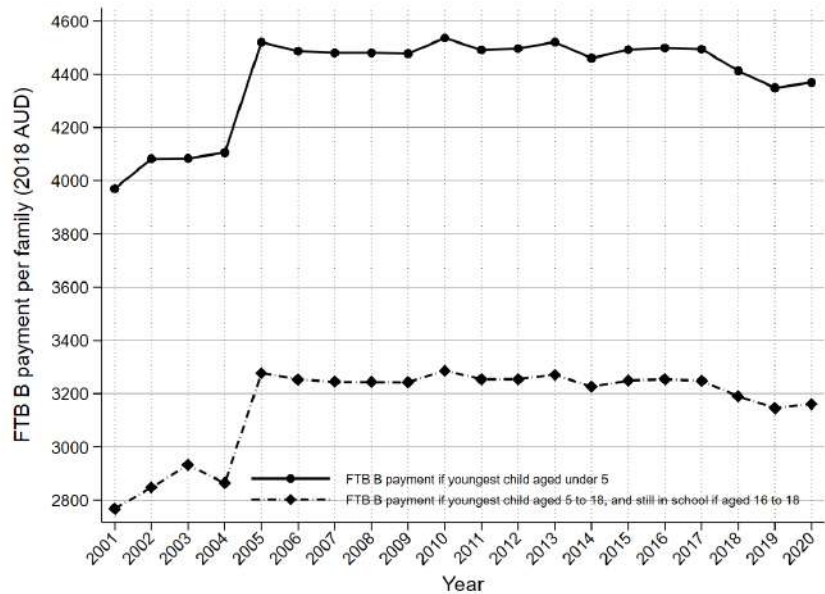


Figure I.13: FTB-B payment rates per family by age of the youngest child

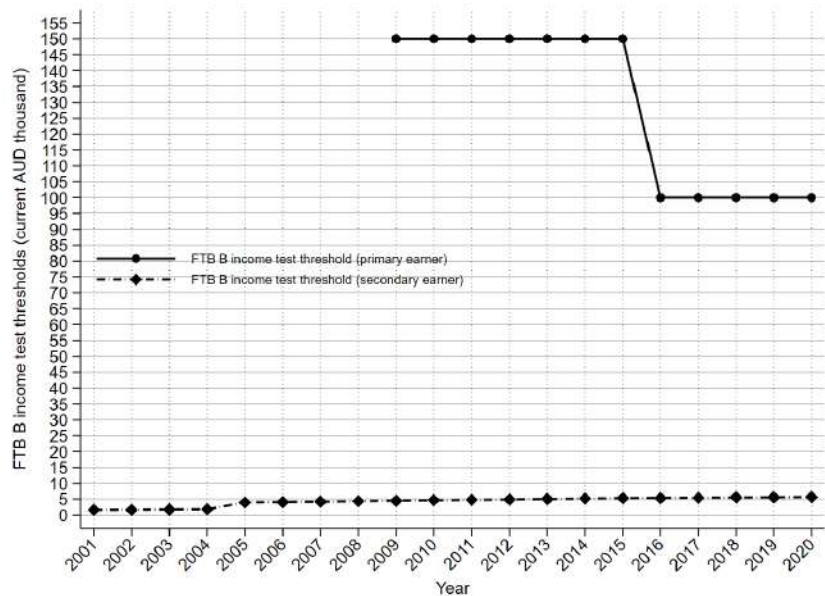
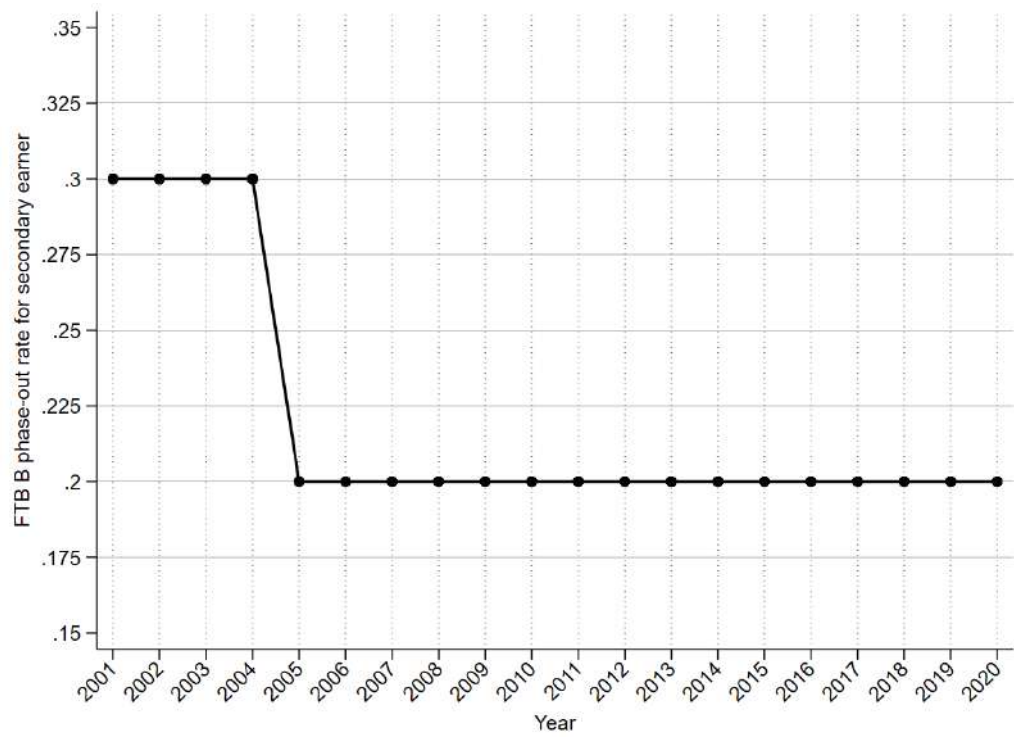


Figure I.14: FTB-B thresholds over time on primary and secondary earners over time



eneral equilibrium

Figure I.15: FTB-B taper rates over time

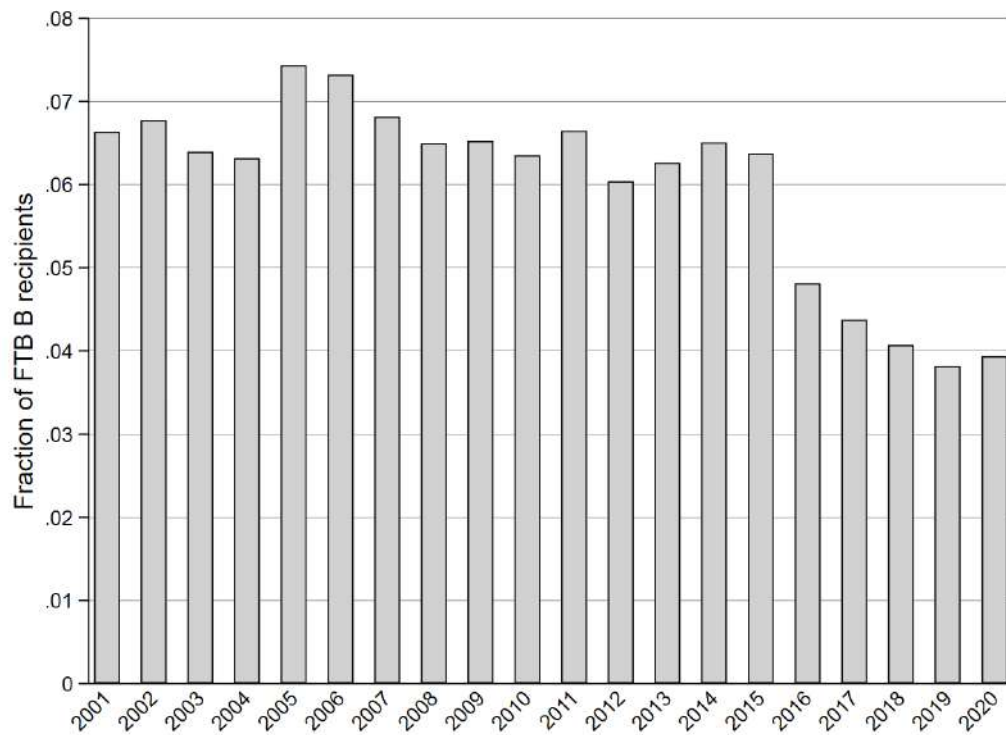


Figure I.16: Proportion of FTB-B recipients over time

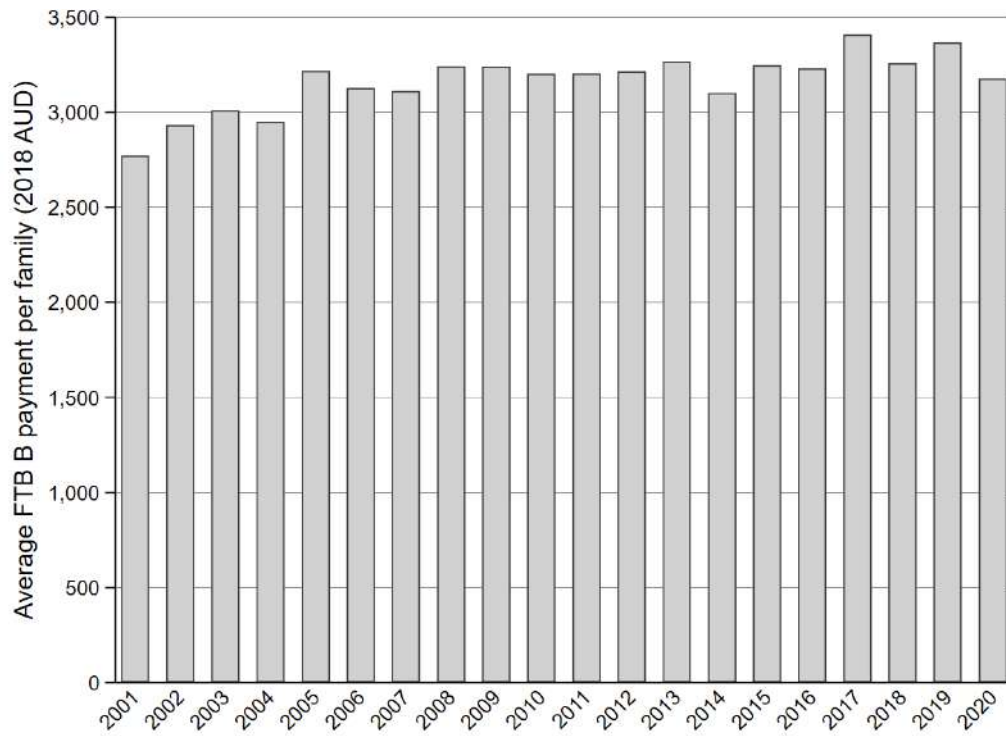


Figure I.17: Average FTB-B payment (2018 AUD) over time

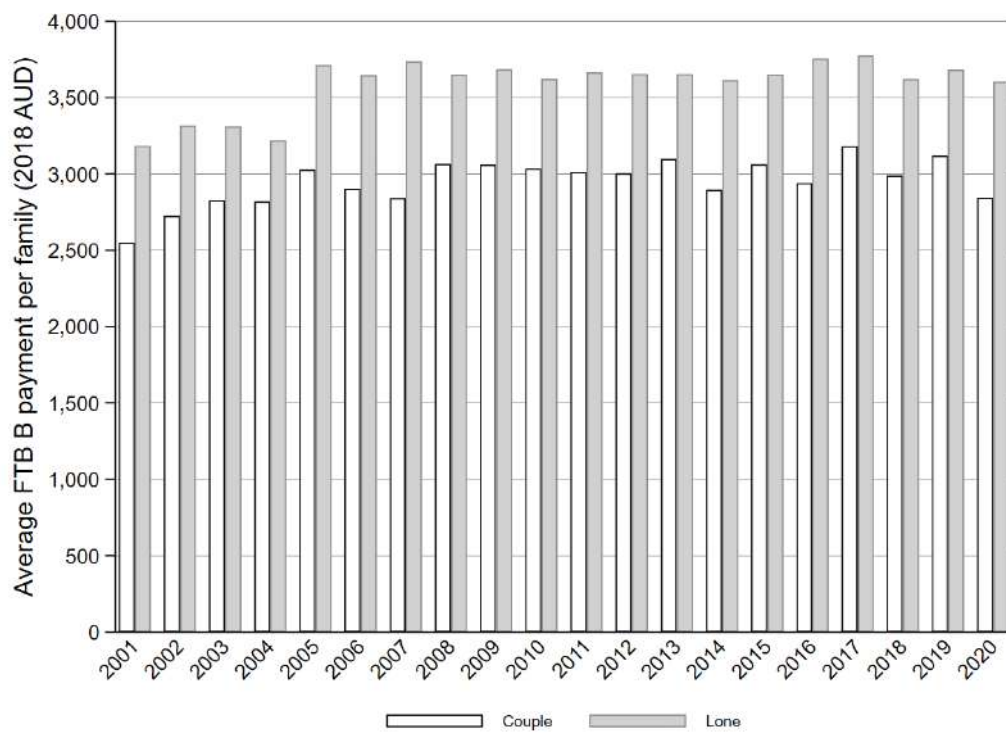


Figure I.18: Average FTB-B payment by marital status.

Because FTB-A recipient status is necessary for a household to access the FTB-B benefits, we can infer from Figure I.10 and Figure I.16 that the majority of FTB-A households also claimed the FTB-B. Although the FTB-A is the larger of the two benefits, the FTB-B offers a non-trivial amount. As shown in Figure I.13, the FTB-B payment remained steady at approximately \$4,500 for eligible families whose youngest child is under 5 years of age, and \$3,200 if their youngest child is between 5 and 18 years old.

At the extensive margins, the proportion of claimants fell over time. Compared to the 2000s and the first half of 2010s, the fraction of partnered FTB-B households dropped by nearly 50% by 2018 (Figure I.16). This could be partially explained by factors similar to those affecting the FTB-A, such as fertility trends and threshold creep. For the FTB-B in particular, the recent drop in couple recipients 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 decreased further to \$100,000 (current AUD). These stricter measures, which complemented the existing test on secondary earners, significantly reduced the claimant pool. However, because the primary earner's income test exclusively determines eligibility (controlling the extensive margin), it had no discernible effect on the average benefit rate for recipients. The right panel of Figure I.18 demonstrates that in 2020, eligible single parents could still expect to receive over \$3,500, while couple parents could expect just under \$3,000 — similar to the amount they would receive in 2005.

I.4 Supplementary figures: CCS-related statistics

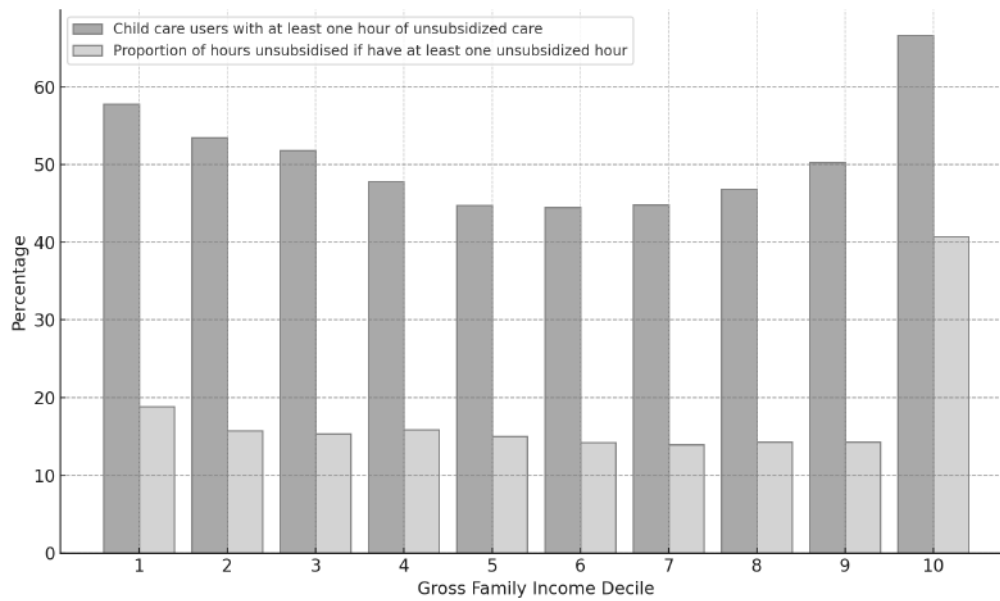


Figure I.19: Proportion of hours paid for that are unsubsidized by gross family income decile in 2018-19 financial year.

Notes: This figure uses data from Table 31 in the 2021 Child Care Package Evaluation report by the AIFS. The lowest decile earned at most \$31,399. The top decile earned \$240,818 or more.

Figure I.19 illustrates the proportion of unsubsidized child care hours, highlighting the program's expansive coverage. Excluding the top decile, the majority of families received fully subsidized child care. Case in point, between 50-55% of families situated around the median income received full subsidies. The prevalence of families with at least one hour of unsubsidized child care increases among the lower deciles, likely due to the work activity requirement. Yet, approximately 40% of families in the bottom decile still received full subsidies. Additionally, even among families with at least one unsubsidized child care hour, provided that they were not in the top income bracket (with annual earnings above AUD 240,818), the average unsubsidized hours did not exceed 20% of their total child care hours.

J Numerical solution method and algorithm

The quantitative model is solved numerically in FORTRAN. I solve the model (a small economy with open capital market) for household optimal allocations, their distributions, and aggregate variables along the initial balanced-growth path steady state equilibrium. The model economy is calibrated to the Australian economy's key micro and macro economic moments during 2012-2018, a relatively stable period. 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 bounded by a_{max} , and (ii) there is enough margin for upward adjustment induced by new policy regimes;
 2. In a similar manner, discretize the human capital space $h_{\theta, \ell}^f \in [h_{min, \theta, \ell}^f, h_{max, \theta, \ell}^f]$ for each θ and ℓ types such that
 - Number of grid nodes, $N_H = 25$;
 - $h_{min, \theta, \ell}^f = 1$ for all θ and ℓ ;
 - $h_{max, \theta, \ell}^f = h_{max, \theta, \ell}^m$ for every θ and ℓ ;
 3. Guess the initial values of the endogenous aggregate macro variable L_0 , endogenous government policy variable ζ_0 , 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 wages, w ;
 5. Given the vector of the benchmark macro and micro parameters (Ω_0), such as the parameters governing the stochastic processes of lifespan (ψ) and income (η_m, η_f), factor prices (w, r), and the government policy parameters, I jointly solve the household problems for optimal decision rules on future asset holdings (a^+), joint consumption (c), female labor supply (n) and the value function of households via backward induction (from $j = J$ to $j = 1$) using the value function iteration method. The numerical optimization and root finding algorithms are from [a toolbox constructed by Hans Fehr and Fabian Kindermann](#). For a pair of state vector and employment status (z, ℓ), I solve jointly for $a_+^*(\ell, z)$, $c_+^*(\ell, z)$, and $n^*(\ell, z)$ via backward induction using the value function iteration method. Suppressing ℓ and z to ease notations, the household solution algorithm is detailed below:
 - (a) First, I assume no left-over assets (bequest) at terminal age. Thus, $a_+^* = 0$ for households aged $j = J$. Since $n = 0$ by mandatory retirement for all $j \geq J_R$, I solve for the optimal consumption, c^* , by maximizing the household utility.
 - (b) For $j = 1, \dots, J-1$, an initial guess $a_+ \in [a_{min}, a_{max, j}]$ is provided, where $a_{max, j}$ is the total income a household has at age j . For every guess of a_+ , the corresponding labor supply $n = n(a_+ | \ell, z)$ is such that the optimal intra-temporal trade-off equation (50) is satisfied. Because $EMTR_{n, \lambda}$ and NLI_λ in (50) are labor-dependent and non-linear, I solve numerically for n using a root-finding algorithm, *fzero*;
 - (c) c is obtained via the household budget constraint (49);
 - (d) then solve for the optimal allocations (a_+^*, c^*, n^*) that jointly maximize a household's value using a non-linear solver *fminsearch* from [Fehr and Kindermann's toolbox](#)
 6. Starting from a known distribution of newborns ($j = 1$), and given the households' optimal solutions, compute the measure of households across states and over the life cycle 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 (47);
- For determining the next period measure of households on the asset (a) and female human capital (h^f) grids, employ a bi-linear interpolation method;
7. Accounting for the share of agents who are alive, sum over all state elements to arrive at the aggregate levels of assets (A), consumption (C), female labor force participation (LFP), tax revenue, transfers, and others. L , K , C , I and Y are updated via a convex updating process to ensure a stable convergence;
 8. Given the aggregate macro variables, solve for endogenous government policy variable, ζ , using the government budget balance equation (78);

9. The goods market convergence criterion for a small open economy at time t is

$$\left| \frac{Y - (C + I + G + NX)}{Y} \right| < \varepsilon$$

where

- the trade balance NX is the difference between current and future government foreign debts. That is, $NX = (1 + n)(1 + g)B_{F+} - (1 + r)B_F$ and $B_F = A - K - B$ 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);
- $\varepsilon = 0.001$.

10. If the goods market convergence criterion is not satisfied, return to step 3 with the initial guesses L_0 and ζ_0 being updated with L and ζ from step 7 and 8, respectively.

The steady-state analyses compare the benchmark economy in the initial steady state with a reformed economy in a new steady state. I capture aggregate macroeconomic changes, ex-ante welfare effect (i.e., effect on future newborns), and the redistributive outcomes of a regime shift in the new steady state. The experimental results, therefore, are concerned with the long-run implications of a policy reform.

However, quantifying the full impact of a policy change also requires investigating the macroeconomic, welfare, and redistributive effects on current generations (non-newborn) living along the transition path. Accounting for the transitional dynamics is crucial for grasping the short-run implications when households do not anticipate the policy reform. This necessitates 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 the current model, with high dimensionality of state space and non-linearities brought about by child benefits, 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. I leave this to future endeavors.