Tax Progressivity in Australia: Facts, Measurements and Estimates*

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Abstract

We study trends in progressivity of the Australian personal income tax system after the introduction of a New Tax System (Goods and Services Tax) Act 1999. We employ two methodological approaches: one based on tax liability progression and one based on tax liability distribution. The latter shows a cycle of lesser and greater tax progressivity in Australia between 2000 and 2018. We identify two main drivers of the tax progressivity cycle: lack of automatic indexation and mismatch between the income tax code and the evolution of market income distribution. Active tax policy with frequent adjustments to income brackets, marginal rates and offset levels drive the progressivity level before 2010. Meanwhile, inactive tax policy induces lower levels of tax progressivity after 2010 as the income tax code fails to track the changes in market income distribution. Indexation to inflation can partially mitigate the decline in progressivity; however, it is not a full substitute for a proper tax indexation system with (annual) frequent adjustments. Furthermore, we separate the contributions of taxes and transfers to overall progressivity of the tax and transfer system. We find the redistributive role of transfers is more pronounced.

JEL: E62, H24, H31

Keywords: Income dynamics**;** Inequality; Progressive tax; Parametric tax function; Suits index; Kakwani index; Redistributive effects.

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1 Introduction

Since the introduction of A New Tax System (Goods and Services Tax) Act 1999 there have been several reviews and debates on further reforming Australia's income tax system.[1] A major focus of these reviews and debates is on the progressivity of the tax system. In a progressive tax system, tax liability rises with income. Tax progressivity has efficiency and equity implications that induces strong opinions on how progressive that tax system ought to be. More recently, political battle lines have been drawn over the tax cuts legislated under the Treasury Laws Amendment (Personal Income Tax Plan) Act 2019. A premise often put forth in favour of such tax cuts is that Australia's income tax system is too progressive such that high earners are paying too much tax. Given these ongoing debates, there is much need to measure and examine trends in Australia's income tax progressivity.

How progressive is Australia's income tax system? How has the progressive level changed after tax reforms? How has it evolved over time since the Goods and Services Tax Act 1999? Answering these fundamental questions is important for evidence-based debate on budget and tax reforms in Australia. Recently, Davis et al. (2019) provide a review of recent tax progressivity trends in Australia in a policy paper. However, a sound scientific measure of tax progressivity is essential to better understand the level of, and trends in, tax progressivity in Australia. In this paper, we study the evolution of tax progressivity of the Australian personal income tax system since 2001. Our goal is to provide metrics that can be used to consistently evaluate and monitor trends in the progressivity of the personal income tax system over time.

For our empirical analysis we employ two data sets: Household, Income and Labour Dynamics in Australia Survey (HILDA) and confidentialised unit records of individual income tax returns from the Australian Tax Office (ATO). HILDA is a nationally representative longitudinal study of Australian households and includes rich data on household incomes, taxes, public transfers and demographics. For that reason, we rely on HILDA as a primary data source. For comparison, we use administrative data of individual sample files from tax returns from the Australian Tax Office (ATO). The ATO tax data consists of over 2 million units representative of the entire population of tax payers.[2]

We first document the distributions of income and tax liabilities and properties of the joint distributions of income and tax liabilities across households and over time. We also calculate effective average and marginal tax rates that individuals face. We discuss how the income distribution and taxes have changed since 2001. We next construct various metrics for measuring the progressivity level of the Australian personal income tax system.

In theory, metrics for measuring tax progressivity generally measure the extent to which tax liability increases with income. However, in practice there is no clear consensus on how to measure tax progressivity. The variety of metrics for measuring tax progressivity can be summarized into two main perspectives: (*i*) how tax liability increases as income rises (tax liability progression); and (*ii*) how tax liability is distributed across the income distribution (tax liability distribution).

[1] Recent notable reviews include the "Henry Tax Review" (Henry et al., 2010) and "Better Tax System, Better Australia" (Treasury, 2015).

[2] We have two sets of results estimated from HILDA and ATO data. The former is reported in the main text, while the latter is reported in Appendix. We find that the two results are fairly consistent with each other.

The tax progression approach has a long tradition in public finance going back to Pigou (1929) and Slitor (1948). According to this approach, a tax system is progressive if the additional tax burden on an additional unit of income exceeds the average tax burden at that income level. This implies an elasticity of tax liability greater than unity, which is equivalent to a positive gap between marginal and average tax rates. This approach is popular in the policy making in Australia (e.g., see Henry et al. (2010), Treasury (2015) and Davis et al. (2019)). Recent developments in the literature estimate elasticities of tax liability using a parametric tax function commonly used in the public finance literature (e.g., see Jakobsson (1976) and recently Heathcote, Storesletten and Violante (2017)). However, to the best of our knowledge we are not aware of empirical work for Australia. In order to fill this void we estimate the parametric tax function using HILDA and ATO data. Our results show that the tax function well represents the Australian income tax code.[3] Importantly, our estimates of the tax elasticity indicate that the level of tax progressivity has been lower, compared to the level in 2001. This result is consistent with a common belief in Australia since the introduction of the Goods and Services Tax Act. Interestingly, our estimates show an upward trend in tax progressivity in recent years.

Differently, the tax liability distribution approach measures tax progressivity in terms of how tax liabilities are unevenly allocated across the income distribution. In essence, this measures the share of tax paid by individuals relative to their share of total income. A more progressive tax system is one where the tax liabilities are distributed more unequally toward the higher end of income distribution. Suits (1977) and Kakwani (1977) generalize this idea and formulate a tax progressivity index, called the Suits index and Kakwani index. The Suits index is in essence a relative concentration coefficient for tax contribution inequality. It has values between $+1$ and -1. In a proportional tax system, where everyone pays the same share of their income in tax, the Suits index would be 0. A negative value indicates a regressive tax system; meanwhile, a positive value indicates a progressive tax system. The tax system is most regressive when the Suits index is -1, and most progressive when the Suits index has a value of $+1$, where the entire tax burden is allocated to members of the highest income group. Closer to $+1$ on the Suits index, the more progressive the income tax system.

Our estimates of the Suits progressivity index show different trends in tax progressivity. The level of tax progressivity changes year to year and tends to move in a cycle of greater and lesser tax progressivity, namely tax progressivity cycle. Specifically, there is a general downward trend from 2001 to 2006, followed by a sharp rise till 2009 and 2010, and then another decline afterwards. Our estimates of the Kakwani index also show a similar pattern of tax progressivity cycle. The fluctuated series of the Suits progressivity index have been found in the previous literature, using different datasets. Smith (2001) finds levels of tax progressivity measured in terms of the Suits index are peaked in the early 1950s, followed a decline till the late 1970s, and then stayed relatively steady until 1997. Herault and Azpitarte (2015) find progressivity of the Australian tax system has declined from a peak value in 1997 and then increased in 2007 and 2009.

The discrepancies in trends in tax progressivity in Australia are interesting; however, they

[3]Heathcote, Storesletten and Violante (2017) also find this parametric tax function fits the US income and tax data very well. Holter, Krueger and Stepanchuk (2019) estimate a similar tax function for several OECD countries.

are not surprising results because of differences in measurement. Intuitively, the tax liability progression approach provides a "local" metric that measures how tax liabilities progress at certain points of the income distribution, which is technically equivalent to a relative distance between marginal and average tax rates at certain income level. However, it does not provide an overall view of how such tax liabilities are distributed across different income groups. The Suits and Kakwani indices fill this gap as they are "global" metrics that measure the distribution of tax liabilities relative to income distribution. Thus, the two approaches are complement and provide us different perspectives on tax progressivity in Australia.

Importantly, the tax liability distribution approach is analytically flexible and enable us to conduct a wide range of counterfactual analysis. We are able to identify the quantitative role of the driving factors behind trends in tax progressivity. We show that the tax progressivity cycle has been driven by lack of automatic indexation and a cycle of active and inactive tax policy, which results in a mismatch between the income tax code and the evolution of income distribution. During periods of active tax policy, frequent adjustments to the income thresholds for the statutory tax schedule and the Low Income Tax Offset lead to an increase in levels of tax progressivity. However, when tax policy is left inactive (that is, during periods of infrequent adjustment to no change in the tax code), progressivity declined. This is due to the effects of bracket creep, as changes in the income distribution pushed more taxpayers onto higher tax brackets. We find that automatic indexation of income tax thresholds to the consumer price index (CPI) can eliminate bracket creep and partially maintain a rather stable level of tax progressivity in early 2000s. However, it fails to mitigate the decline in tax progressivity in a longer period where the real component of income growth is more pronounced. In short, indexation to the CPI is not a full substitute for an active tax policy that has frequent adjustments to the tax schedule so as to keep the income tax code in line with the dynamics of income distribution.

In extension, we examine the redistributive role of the income tax system in the wider context of the overall tax-transfer system. We estimate the redistributive effect of taxes and transfers by measuring the difference in the Gini coefficient of pre- and post- tax and transfer incomes. While tax progressivity plays a crucial role in the overall redistribution, it is relatively small in comparison with the redistributive effect of the transfer system. In addition, while tax progressivity governs the redistributive effect of the tax system, overall redistribution from the tax-transfer system depends mostly on the size of transfers. Our finding provide another empirical evidence for the debate on the role of income taxes and transfers in mitigating income inequality. Herault and Azpitarte (2015) examine the redistributive impact between 1994 and 2009, using the Australian Survey of Income and Housing Costs (SIHC). They find that after reaching a peak value in the late 1990s, the redistributive effect of the tax and transfer system declined sharply. Our estimates resulting from HILDA data indicate a similar decline in redistributive role of the tax and transfer system between 2001 and 2009. However, we find this trend reverses after 2010.

We also highlight the quantitative importance of accounting for household heterogeneity when measuring tax progressivity using household survey data. The magnitude of such tax distribution index as Suits or Kakwani index is sensitive to the parametrization of the adult equivalence scale. Taxes and transfers depend on age, family structure and a variety of other demographic factors. While accounting for household demographics shifts down the trends in

the Suits index, the cyclical pattern obtained from the household level data is similar to the one obtained from the individual level data. Thus, the tax progressivity cycle is robust to the change of measurement unit from individual to household.

Finally, our findings have implications for the topical debate on inequality and tax reforms in Australia, which recently has animated many Australians. Both sides of politics appear certain about how to reform the progressive tax and transfer (fiscal) system to address inequality. However, to the best of our knowledge there has been no clear understanding of how progressive the fiscal system is in recent years. Our findings fill in that gap and also highlight the importance of sound policy research in the first place and its implications for better policy debate and outcome.

Related studies. We now position our study in the previous studies examining fiscal progressivity and redistribution in Australia. We are not the first to examine tax progressivity in Australia, but the first to apply both tax progression and tax distribution measures to the context of Australia.

One of the earliest papers that examined tax progressivity in Australia is by Kakwani (1977), in which the author examined income tax statistics for Australia ($1962-1972$), Canada ($1966-1972$), Britain ($1959-1967$) and the United States ($1958-1970$). Kakwani found that there were relatively small differences in the degrees of income inequality before and after tax, except for the US. He also found that during the period, Australia had the highest degree of tax progressivity compared to the other advanced economies. Hodgson (2014) explores the relationship between personal income tax rates and means tested transfer payments in Australia from 1970 to 2014. She documents the major reforms in taxes and transfers during that period. She argues that the Australian tax and transfer system shifted from one with highly progressive tax rates coupled with universal benefits to flatter tax rates coupled with more targeted and means tested benefits.

Smith (2001) applies the tax distribution approach and provides a comprehensive study on tax progressivity in Australia. She estimates the degree of income tax progressivity from 1917 to 1997 from Australian official income taxation statistics, using 3 indices of tax progressivity - the Kakwani (1977) index, Suits (1977) index and Musgrave and Thin (1948) index. She finds a peak in tax progressivity in the early 1950s on the Kakwani and Suits indices and a strong decline till the late 1970s followed by a relatively steady trend until 1997. She also finds that only a slight temporary increase in progressivity was associated with tax reforms in the 1970s and 1980s. The results with Musgrave and Thin index were ambiguous in direction with occasional peaks. Smith (2001) only uses taxation statistics and does not extend beyond 1997. Herault and Azpitarte (2015) use the Australian Survey of Income and Housing Costs (SIHC) from 1994 and 2009. They find the Kakwani index declined from a peak value of 0.27 in 1997 to 0.23 in 2005, and increased in 2007 and 2009. We extend the tax distribution approach to a more recent and important period since the introduction of New Tax System Act 1999. We employ two new datasets: survey data (HILDA) and administrative data (ATO sample of tax records). We show that the levels of tax progressivity in Australia have been deteriorated sharply after 2010.

Our paper is related to a number of empirical studies on the redistributive effects of the Australian tax and transfer system. Whiteford (2010; 2014), Wilkins (2014) and Herault and

Azpitarte (2015) are notable studies that examine trends in the redistribution and progressivity of both taxes and transfers in Australia. Whiteford (2010) provides a detailed examination of the progressivity of the Australian transfer system together with taxes by examining the ratio of transfers paid to the poorest quintile to those paid to the richest quintile between the mid 1990s to 2005 and the concentration coefficient for transfers from 1980 to 2000. He concludes that Australia has one of the most progressive systems of direct taxes of any OECD country. Wilkins (2014) studies income inequality between 2001 and 2010, using the Survey of Income and Housing (SIH) and the Household Income and Labour Dynamics in Australia (HILDA) survey. He shows that the effect of taxes on reducing income inequality declined in all income series used in the analysis. Wilkins (2014) and Whiteford (2010; 2014) are descriptive in essence and focus more on summary statistics of redistribution at various income levels rather than on examining measures of progressivity.

Our study overlaps with Herault and Azpitarte (2015) that examines trends in the redistributive impact of the tax and transfer system between 1994 and 2009 using the Australian Survey of Income and Housing Costs (SIHC). They measure the redistributive effect as per Reynolds and Smolensky (1977). They also compare the Gini index of pre-fiscal income (before tax and transfers) to post-fiscal income (after tax and transfers). They find that after reaching a peak value in the late 1990s, the redistributive effect of the tax and transfer system declined sharply. Differently, we HILDA and ATO data and find a similar declining trend in the redistributive effect from 2001 to 2009. However, when we go beyond 2009 we find a reversed tax progressivity trend.

There is a large literature on inequality in Australia. For example, Leigh (2005) derives long-run inequality series from tax data. Wilkins (2015) documents trends in income inequality in Australia using household survey data and find a slight increase in income inequality over recent years. Chatterjee, Singh and Stone (2016) examine the rise in labour income inequality over the past decade using HILDA. Kaplan, Cava and Stone (2018) document the facts on consumption and income inequality among households in Australia, emphasizing the role of the rents imputed to home owners for conclusions about inequality. Differently, we document the joint distribution of income and tax liability using ATO data and also HILDA data. Our focus is different as we aim to estimate the progressivity level of the Australian personal income tax system.

The paper is structured as follows. Section 2 provides an overview of Australia's personal income tax system. Section 3 provides a description of the datasets and descriptive statistics. Section 4 presents two measures of tax progressivity and estimates and examines the driving forces behind the changes in tax progressivity. Section 5 presents extensions. Section 6 concludes. Appendices report additional results and further discussion.

2 The Australian personal income tax system

2.1 Overview

Australia ranks among those countries with the lowest overall tax burden (as measured by total tax revenue as a percentage of GDP). Personal income taxes are the most important revenue source of the Australian tax system. The tax revenue collected from personal income

as a percentage of GDP has been considerably higher than the OECD average. It accounts for nearly 40 per cent of all tax revenue, the second highest among the OECD countries after Denmark (OECD 2018)

The core components of the Australian income tax system includes a progressive income tax schedule with statutory marginal tax rates that increase from one specified income threshold to another, levies, concessions and tax offsets. The progressive tax schedule is applied to total taxable income after deducting eligible expenses incurred in generating that income.

While the progressive tax schedule is fairly simplistic, tax offsets, levies and concessions are more complex and often subject to different rates, thresholds, taper rates and means tests. The low-income tax offset (LITO) is available in full for individuals below a specified low income threshold, and then gradually tapered above that till a specified high income threshold. In addition to the LITO, there are a number of other tax offsets that apply to specific demographic groups such as the senior Australians and pensioners tax offset (SAPTO) and employment termination payments tax offset Hodgson (2014). The personal income tax system also includes certain levies and concessions on certain types of incomes, i.e., capital gains and superannuation. A permanent levy called the Medicare levy is applied at a flat rate on the entire taxable income beyond a certain income threshold. In addition to the Medicare levy, a Medicare levy surcharge applies on those individuals above a specified income threshold without private health insurance.

2.2 Major changes to the personal income tax (2001 - 2016)

The structure of the Australian income tax system has changed dramatically during the 2000s. This change was mainly due to the landmark legislation titled A New Tax System (Goods and Services Tax) Act 1999 in which the Goods and Services Tax (GST) was introduced so as to reduce the reliance on income tax. Within each complex component of the income tax, rates, thresholds and taxable income have gone through periodical adjustments often on an yearly basis. In this section, we highlight the major changes that have influenced progressivity of the tax system during the period[4].

The income tax thresholds were not indexed, but periodically adjusted along with the marginal rates. There have been significant changes within the components of the Australian income tax system since 2001. Table 1 summarizes the major changes. As seen from Table 1, there have been periods of substantial changes to the tax system and periods where there were very minor changes. In this regard, 2006 - 2013 can be marked as a period of active tax policy with frequent changes, while 2001 - 2006 and 2013 - 2016 were periods of inactive tax policy with relatively little changes.

The top threshold in 2004 was at $\$62,500$ compared to $\$180,000$ in 2016. This threshold was raised each year from 2005 to 2007, with the steepest rise in 2007 from $\$95,000$ to $\$150,000$. Although the marginal tax rates were relatively constant, the change in the income thresholds indirectly reduced the marginal tax rates for the top income earners. Comparatively, middle income earners faced relatively little change in their tax burdens.

Increases in the top threshold were also coupled with reductions in the tax burden of the

[4]In Australia, the income year is the full financial year beginning on 1 July and ending on 30 June of the following year. For brevity, we refer to each income year by the year in which the income year ends. For example, we refer to the income year 2003-04 as 2004 throughout the paper.

Table 1: Statutory income thresholds for the personal income tax and low income tax offset

	Income tax thresholds				Low Income Tax Offset (LITO)		
	Threshold 1	Threshold 2	Threshold 3	Threshold 4	Maximum offset	Threshold 1	Threshold 2
2001-2003	6,000	21,600	50,000	60,000	150	20,700	24,450
2004	:	:	52,000	62,500	235	21,600	27,475
2005	:	:	58,000	70,000	:	:	:
2006	:	:	63,000	95,000	:	:	:
2007	:	25,000	75,000	150,000	600	25,000	40,000
2008	:	30,000	:	:	750	30,000	48,750
2009	:	34,000	80,000	180,000	1,200	:	60,000
2010	:	35,000	:	:	1,350	:	63,750
2011	:	37,000	:	:	1,500	:	67,500
2012	:	:	:	:	:	:	67,500
2013-2016	18,200	:	:	:	445	37,000	66,667

Note: Year refers to the year in which the income year ends. For instance, 2008 refers to the income year from 1st July 2007 to 30th June 2008. Marginal tax rate is a specific tax rate applied to each income bracket given by specific income thresholds. Marginal tax rates usually increase from low to high income brackets. In Australia, there are five income brackets. The corresponding marginal tax rates are 0%, 17%, 30%, 42% and 47% in 2001 and 0%, 19%, 32.5%, 37% and 47% in 2016. Further details to changes in income thresholds and marginal rates for income taxes, low income tax offsets (LITO) and senior Australian and pensioner tax offsets (SAPTO) are reported in the Appendix. The income thresholds are in nominal values. Cells with : denote values that are the same as previous year values.

lowest income earners through changes to the LITO. From 2006 to 2012, the government gradually increased the LITO thresholds. There was also a steep increase in the maximum offset from \$235 in 2006 to \$1,500 in 2012. This served to reduce the effective tax rate at the bottom thresholds. In 2013, the statutory tax-free threshold was tripled from \$6,000 to \$18,000 and the LITO was adjusted to reflect this change, with a reduction of the maximum offset amount to \$445. Low income earners have been largely relieved of income tax.

3 Data and descriptive statistics

3.1 Data

We employ two data sets in our analysis: (1) Restricted (unconfidentialised) data from the Household, Income and Labour Dynamics in Australia Survey (HILDA) and (2) confidentialised unit records of individual income tax returns from the Australian Tax Office (ATO). The analysis is primarily based on HILDA data. The HILDA survey collects detailed information on respondent's annual income that allows for an estimation of total personal and household incomes. Public transfers, income tax and after tax net income are estimated. In addition, the rich set of information included in the survey allows for more accurate estimations of tax payments. Further, the sample is not dependent on individuals lodging tax returns; therefore, it is more representative of the Australian population compared to the ATO sample. In addition, HILDA is relatively stable in its survey methods and income measures and there is a strong emphasis on preserving longitudinal consistency (Wilkins, 2015).

Our unit of measurement is an adult individual who legally pays taxes in Australia. The notion of income in our analysis encompasses all income flows accruing to the sampling unit: labor income, capital/asset income and private transfers. We define this as pre-government (before tax and transfer) income. We then add taxes to have post-tax and pre-transfer income. We finally add public transfers and consider post-government (after tax and transfer) income.

[5] The income tax schedule and income tax bases are in nominal values. Unless explicitly mentioned, all income, tax liabilities and transfers are expressed in nominal terms.

We restrict our sample of the Restricted HILDA data to those individuals with non-negative income and tax liability. We drop any observations where the average tax rate exceeds the top marginal tax rate for a given year. Around 5% of the HILDA data were excluded. Our final sample consists of $299,662$ units in total. We report the results estimated from the Restricted version of HILDA $2001-2016$ in the main analysis. We extend our analysis to use the General (confidentialised) version of the HILDA data $2001-2018$ in Appendix. For comparison, we report the results estimated from the ATO sample $2004-2016$ in Appendix.

3.2 Descriptive statistics

We begin by briefly documenting trends in pre-government income and tax liabilities across the income distribution from 2001 to 2016 using the HILDA data.[6]

Table 2: Summary statistics from HILDA 2001

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Pre-gov. income			Tax			Relative share	Tax rate	
Quantile	Mean	Share	Cumulative	Mean	Share	Cumulative	Tax share/Income share	Marginal	Average
Quintile 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quintile 2	2,505.81	2.20	2.20	1.03	0.00	0.00	0.00	0.68	0.03
Quintile 3	13,134.00	11.52	13.72	478.12	2.05	2.05	0.18	8.18	3.46
Quintile 4	30,063.78	26.38	40.10	4,544.80	19.49	21.54	0.74	27.25	15.22
Quintile 5	68,261.52	59.90	100.00	18,298.51	78.46	100.00	1.31	39.69	24.63
Top 1%	212,245.25	9.31	100.00	79,851.83	17.12	100.00	1.84	47.00	36.25

Note: The table reports the descriptive statistics of income and tax liabilities from HILDA data in 2001. Column (1) lists the mean nominal pre-government (before tax and transfer) income for each quantile. Column (2) presents the share of total pre-government income earned by the quantile. Column (3) shows the cumulative shares. Columns (4) to (6) repeats the same statistics by quantile for tax payment/liability. Column (7) reports the share of tax liability for each quantile relative to their share of income, namely, Relative Share of Tax (RST). Columns (8) and (9) presents the marginal and average tax rates averaged by quantile.

Income and tax liabilities. Tables 2 presents the descriptive statistics of the distribution of pre-government income and tax liabilities in 2001. It highlights the substantial degree of concentration of both pre-government income as well as tax liabilities at the top half of income distribution. The bottom 40% earned only 2.2% of total pre-government income. With a mean pre-government income less than the tax free threshold, these low income individuals were not liable for any tax payments. Meanwhile, the richest 20% of individuals earned around 60% of total pre-government income and were liable for 79% of total tax payments. The top 1% stands out from the rest of the income distribution with 9.3 of total income and 17% of total tax payment in 2001.

The share of tax payments is higher for higher income groups. Column 7 in Tables shows the share of taxes relative to the share of income earned by each quintile. In 2001, the share of total tax paid by the top 1% was 1.8 times their share of total income. The share of total taxes

[5] We report the results for pre-tax and post-transfer income, and post-tax and post-transfer income in Section 5. Herault and Azpitarte (2015) use a similar measurement of income, but call it post-fiscal (after tax and transfer) income. In addition, we also consider household as a measurement unit that pays taxes to and receives transfers from the government in Section 5.

[6] We provide a detailed description of the distribution of pre-government income and tax liability from both HILDA and ATO data in our technical appendix.

Table 3: Summary statistics from HILDA 2016

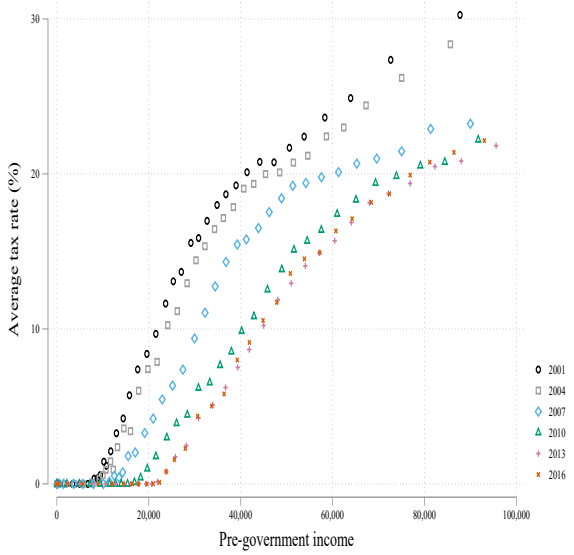
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Pre-gov. income			Tax			Relative share	Tax rate	
Quantile	Mean	Share	Cumulative	Mean	Share	Cumulative	Tax share/Income share	Marginal	Average
Quintile 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Quintile 2	7,789.98	3.42	3.42	0.05	0.00	0.00	0.00	0.06	0.00
Quintile 3	27,992.61	12.29	15.71	892.02	2.12	2.12	0.17	11.01	2.79
Quintile 4	56,207.10	24.68	40.39	8,127.42	19.33	21.45	0.78	30.70	14.47
Quintile 5	135,740.01	59.61	100.00	33,034.04	78.55	100.00	1.32	37.62	23.61
Top 1%	512,936.88	11.26	100.00	133,765.17	15.90	100.00	1.41	47.00	27.65

Note: The table reports the descriptive statistics of income and tax liabilities from HILDA data in 2016. Column (1) lists the mean nominal pre-government (before tax and transfer) income for each quantile. Column (2) presents the share of total pre-government income earned by the quantile and column (3) shows the cumulative shares. Columns (4) to (6) repeats the same statistics by quantile for tax payment/liability. Column (7) reports the share of tax liability for each quantile relative to their share of income, namely, Relative Share of Tax (RST) given by $\text{RST}_i = \frac{\text{Percent of total tax liability by quintile } i}{\text{Percent of total income earned by quintile } i}$. Columns (8) and (9) presents the marginal and average tax rates averaged by quantile.

relative to the share of income increases with increasing incomes indicating a progressive tax system. This is also reflected in the marginal tax rates (column 8) and average tax rates (column 9). Both marginal and average tax rates increase as income increases. The top marginal tax rate was 47% while marginal tax rates around the median averaged at 17% in 2001. As the average tax rates below the marginal tax rates, the tax system has a progressive structure.

Table 3 reports the summary statistics for 2016. The income shares by quintile are quite similar to 2001, except for the highest income group. The income share earned by the top 1% increases from 9% to 11%. Conversely, their share of tax liability decreased from 17% to 16%. As a result, there is a decline in relative share tax (RST) at the top from 1.8 to 1.4. This reduction in tax liability is also observed by the fall in average tax rate from 36% in 2001 to 28% in 2016. Comparing 2016 with 2001 reveals that the relative tax liabilities at the bottom had declined significantly with very small changes at the top. There also has been a decline in average tax rates for the bottom 4 deciles.

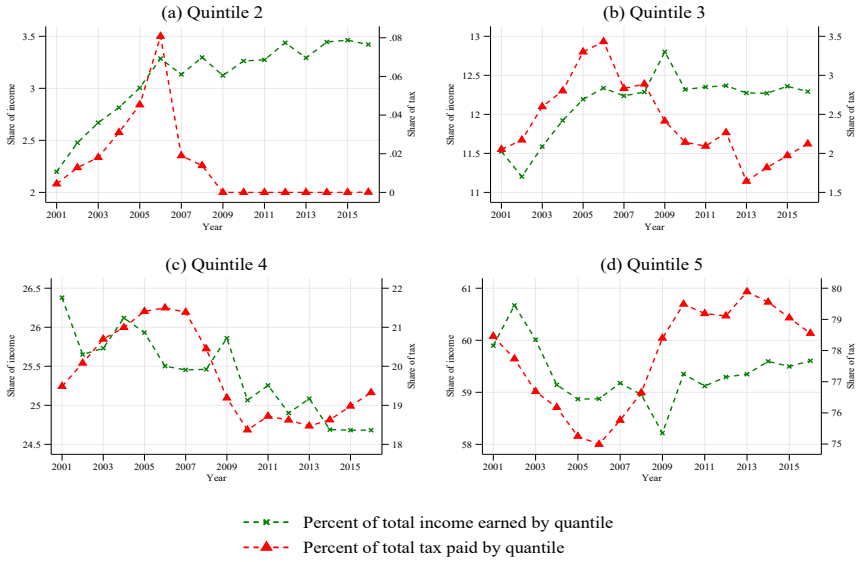
Figure 1: Average tax rates by income



Note: Average taxes rates are taxes as fraction of income. This figure displays the average tax rates by levels of pre-government income in Australia from 2001 to 2016.

Average taxes. Figure 1 reports the average tax rates (taxes as a fraction of income) by income over time. There has been a significant reduction in the average tax rate. Compared to all other years, 2001 shows higher average tax rates at all income levels. For example, the average tax rate decreases from around 19% to 8% at the income level of $\$40,000$. The figure displays a rightward shift from 2001 to 2016. The effective tax free threshold has increased by a large extent. This is due to changes in the statutory thresholds and those for various offsets. An increase in the tax free threshold tends to reduce tax burdens at the bottom and make the system more progressive. However, at the same time, the tax code has also become flatter with relatively lower tax rates at the top in 2016 compared to earlier years indicating a reduction in progressivity.

Figure 2: Trends in income and tax shares by quintile



Note: This figure shows pre-government income shares and tax shares by income quintile from 2001 to 2016 using HILDA data. The green line is the share of the total income while the red line is the share of total tax liability. Quintile 1 is omitted because income and tax shares remained at 0%.

Relative income and tax shares. Figure 2 reports trends in the percent of total income and the percent of total tax liability by quintile from 2001. The bottom quintile has been omitted as income and tax shares remained at 0% at the bottom throughout the period. The share of income earned by the middle quintiles decreased while their share of tax liability increased from 2001 to 2002. Meanwhile, the share of income earned at the top increased while their tax share decreased. Between 2001 and 2006, both the tax share and income share of quintile 2 increased. During the same period, the top quintile experienced both a decline in their share of income and their share of tax liability. For most years, quintiles 3 and 4 follow trends in quintiles 2. After 2007, there were practically no changes in tax share for quintile 2. However, between 2007 and 2010, tax shares at the top quintile was on an upward trend while quintiles 3 and 4 experienced a sharp fall in their tax shares. Since 2013 the tax share of the top quintile has been decreased while quintiles 3 and 4 experienced an increase in their tax shares.

While descriptive statistics provide important snapshots of progressivity across the income distribution, they do not provide us with a simple indicator of how the overall progressivity of the tax system evolves over the period. It is difficult decipher trends in progressivity by comparing tables such as Tables 2 and 3 for each and every year. This motivates the need for constructing metrics to measure the overall level of tax progressivity that would pick up subtle changes in the income tax system over time.

4 Measuring tax progressivity

In this section, we formulate two metrics that enable us to quantitatively describe how progressive the Australian tax system is, and examine the evolution of tax progressivity over time. In general, tax progressivity is defined as the extent to which tax liability increases with income. There are various metrics for measuring tax progressivity, which can be summarized into two

main perspectives: (i) how tax liability increases with income (tax progression); and (ii) how tax liability is distributed across the income distribution (tax distribution).

4.1 Tax progression metric

Musgrave and Thin (1948) define a progressive tax system as one where tax liability progresses when moving up the income scale. This can be expressed in terms of the progression of average and marginal tax rates, total tax liability or residual income. All these expressions are consistent with each other and can be intuitively interpreted through the lens of elasticity of tax liability with respect to income. Thus, our tax progression measure is based on this elasticity concept.

In order to illustrate this measure, consider an individual whose income and tax liability are level y and T, respectively. The elasticity of tax liability with respect to income is given by $\varepsilon = \frac{\partial T}{\partial y}\frac{y}{T}$. Let $m(y) = \frac{\partial T}{\partial y}$ and $t(y) = \frac{T}{y}$ be marginal tax rate and average tax rate, respectively. The elasticity of tax liability can be expressed in terms of a ratio of marginal tax rate to average tax rate as $\varepsilon = \frac{m(y)}{t(y)}$. If the elasticity is larger than unity, $\varepsilon > 1$, additional tax liability on an additional unit of income (marginal rate) exceeds average tax liability at that income level (average rate), i.e., $m(y) - t(y) > 0$. In such cases, the tax system is progressive.

The tax progression measure can be calculated by assuming a parametric tax function to summarize the complicated structure of the income tax code in easy-to-interpret parameters. We use a parametric tax function which is commonly used in the public finance literature (e.g., see Jakobsson (1976), Persson (1983), Benabou (2002) and more recently Heathcote, Storesletten and Violante (2017)). Specifically, the parametric tax function has a form of

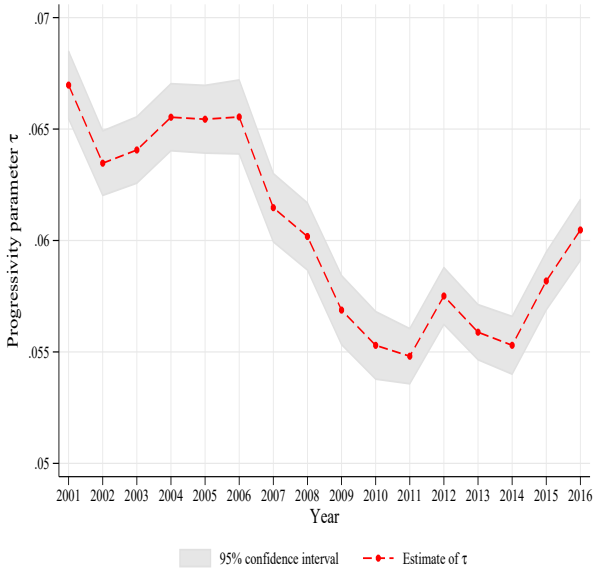
$$T = y - \lambda y^{(1-\tau)},$$

where λ is a scale parameter that controls the level of the average tax and τ is a curvature parameter that controls the curvature of the function. In effect, the curvature parameter τ is a closed-form expression of tax elasticity given by $\frac{m(y)-t(y)}{1-t(y)} = \tau$. When $\tau = 0$, the elasticity of tax liability is zero and marginal and average tax rates are identical, which is a proportional income tax. When $\tau > 0$, the elasticity of tax liability is greater than unity and the marginal tax rate is higher than the average tax rate. The higher the value of τ, the more progressive is the income tax schedule.

Importantly, this parametric tax function approach is empirically appealing as it is straightforward to estimate the two parameters τ and λ from micro data, using the logarithmic transformation of the tax function specification. We estimate the parameters of the parametric tax function for Australia, using data from HILDA and ATO. In general, these two parameters are estimated with a high degree of precision. Around 99 percent of the variation in the data is explained by the tax function and with very low robust standard errors on both the curvature parameter τ and scaling parameter λ. The estimated values of τ are in a range between 0.055 and 0.067. In general, the parametric tax function quite well represents the Australian income tax code and its changes over time.[7]

[7] We report the estimates of the parametric tax function in Table 9 in the accompanying technical appendix. Our results show that this tax function quite well represents the Australian income tax system. Similarly, Heathcote, Storesletten and Violante (2017) finds this parametric tax function fits the US income and tax data very well. Holter, Krueger and Stepanchuk (2019) estimate a similar parametric tax function for several OECD

Figure 3: Levels of tax progressivity measured by the parameter τ



Note: This figure shows the estimates of τ using HILDA 2001-2016. Technically, $\tau = \frac{m(y)-t(y)}{1-t(y)}$ is an index of tax progressivity.

Figure 3 displays the estimates of τ and along with the 95% confidence interval using HILDA from 2001 - 2016. Our result indicates that τ declined for the most of the period. The sharpest decline is from 2006 to 2011 after the top income threshold was increased from \$95,000 in 2006 to \$150,000 in 2007 and \$180,000 in 2009. This was a tax cut for high income individuals, which resulted in only the top 1 percent of the income distribution paying the top marginal tax rate. The taxes as a fraction of income, i.e. average tax rates, have declined significantly during the period. Smaller estimated values of the parameter τ imply that the adjusted average gap between the average and marginal tax rates has been narrowed down due to the tax cuts for relatively high income individuals.

There is an increase in the estimated value of τ for the period of 2015-16. However, the levels of tax progressivity measured by the parameter τ are generally lower than that in 2001. Accordingly, one could conclude that progressivity of the Australian personal income tax system has declined since the introduction of a New Tax System (Goods and Services Tax) Act 1999.

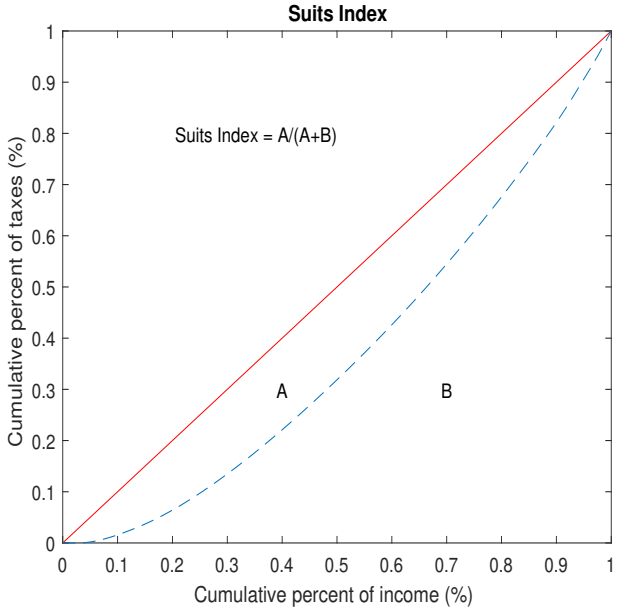
Reflecting overseas trends, we are the first to measure trends in tax progressivity in Australia using the tax progression approach with a parametric tax function. However, it is important to note that the tax progression approach basically measures the gap between marginal and average tax rates at certain points on the income distribution. In essence, it is a "local" metric and the parametric estimate of the parameter τ can only provide an approximation of this local metric. As documented before, the marginal and average tax rates vary considerably across income groups in Australia. It is necessary to have a more general metric that systematically accounts for variation of tax rates and tax liabilities across the income distribution.

countries.

4.2 Tax distribution metric

In this section we consider a metric for measuring tax progressivity that takes into account tax shares relative to their income shares (e.g. see Pfahler (1987)). In the literature, there are two commonly-used measures: Kakwani index (Kakwani (1977)) and Suits index (Suits (1977)). Both indices compare the distribution of tax liabilities ordered by income with the income distribution. Progressivity depends on the extent to which the tax system deviates from proportionality. In essence, these two indices measure how equally tax liabilities are distributed across the whole income distribution. A more (less) progressive tax system is one where the tax liabilities are distributed more (less) unequally toward the upper end of the income distribution.

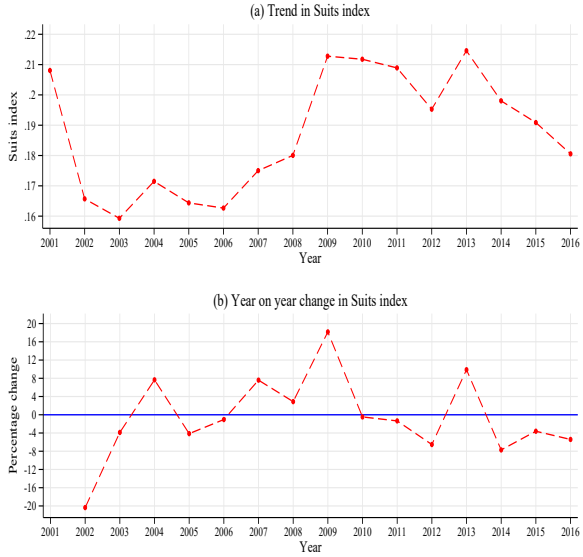
Figure 4: The relative concentration curve of tax and Suits index



Note: The relative concentration curve plots the cumulative proportion of tax liabilities ordered by income against the cumulative proportion of (pre-government) income. The 45 degree line indicates proportionality where tax shares equal income shares. The Suits index for tax is the area between the 45-degree line and the relative concentration curve. The index ranges from -1 for the most regressive tax possible to +1 for the most progressive tax possible, and takes the value zero for a proportional tax.

Figure 4 illustrates how the Suits index is calculated. The curve plots the cumulative proportion of tax liabilities ordered by pre-government income against the cumulative proportion of pre-government income. The 45 degree line indicates proportionality where tax shares equal income shares. A curve below the line indicates a progressive system where tax shares increase with rising income shares and vice-versa. The Suits index is the area between the 45-degree line and the relative concentration curve. The index ranges from -1 for the most regressive tax possible to +1 for the most progressive tax possible, and takes the value zero for a proportional tax.

Figure 5: Levels of tax progressivity measured by the Suits index



Note: This figure reports tax progressivity measured by the Suits index. Panel (a) displays the estimates of Suits index, using HILDA data from 2001 to 2016. Panel (b) displays the percentage changes.

Figure 5 reports the estimates of Suits index using HILDA from 2001 to 2016.[8] Our estimates confirm that the Australian income tax system is indeed progressive. As seen in Panel (a) of Figure 5, the Suits index is around 0.21 in 2001. Interestingly, the trend in tax progressivity are quite different from the one obtained from the tax progression metric. The level of tax progressivity changes year to year and tends to move in a cycle of greater and lesser tax progressivity (tax progressivity cycle). More precisely, there is a general downward trend from 2001 to 2006 with a reduction between 2002 and 2006 by around 20% (see Panel (b) of Figure 5). From $2006 - 2010$ there is a significant increase in tax progressivity. The most significant increase in progressivity is seen from 2008 to 2009. The level of tax progressivity is relatively stable between 2010 and 2013. However, there is a sharp decline since 2013.

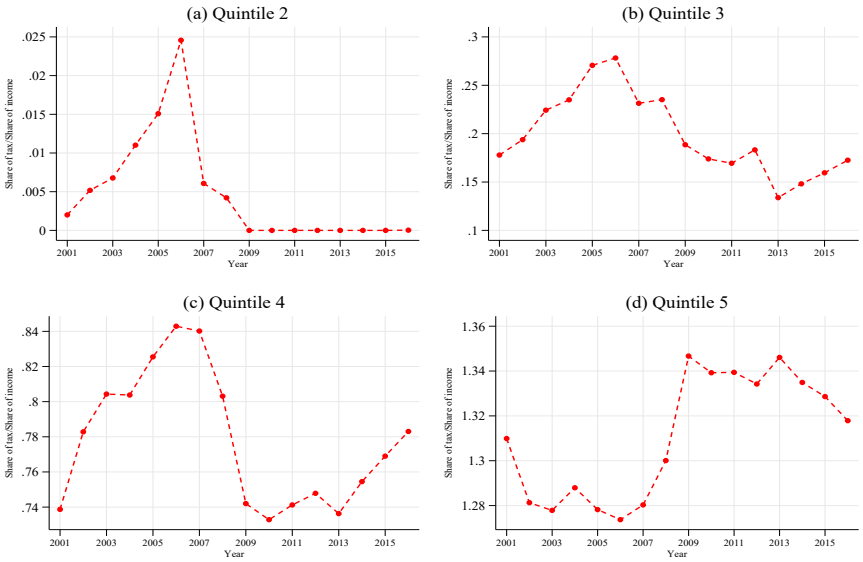
Our findings are connected to the body of Australian research on tax progressivity. Smith (2001) has a similar methodological approach using the Kakwani and Suits indices. She finds a peak in tax progressivity in the early 1950s and a strong decline till the late 1970s and then a relatively steady trend until 1997. She also finds that only a slight temporary increase in progressivity was associated with tax reforms in the 1970s and 1980s. Smith (2001) only use taxation statistics and does not extend beyond 1997. Herault and Azpitarte (2015) use data from the Australian Survey of Income and Housing Costs (SIHC) from 1994 to 2009. They find progressivity of the Australian tax system has declined from a peak value in 1997 and then increased in 2007 and 2009. By employing a different dataset (HILDA) we confirm their progressivity trends for $2001 - 2009$, and by extending the period till 2016 we find a cycle of lesser and greater tax progressivity since 2001.

The Suits index is a useful indicator for summarizing overall tax progressivity. However, it does not identify which parts of the distribution are responsible for any changes over time. To complement the analysis, we report how much of tax and income shares by each income quintile

[8] We present trends for the Suits index in the main paper and report estimates of the Kakwani index in Appendix.

have changed over time.

Figure 6: Trends in tax shares relative to income share



Note: This figure shows tax shares relative to pre-government income shares (RST) by income quintile from using HILDA 2001-20016. Quintile 1 is omitted because its income and tax shares remained at 0%. The share of tax relative to share of income (RST) by income quintile is given by $\text{RST}_i = \frac{\text{Percent of total tax liability by quintile } i}{\text{Percent of total income earned by quintile } i}$.

Figure 6 displays the trends in tax share relative to income share by quintiles. Between 2001 and 2007, quintiles 2 - 4 experienced an increase in their tax shares relative to their income shares, while the top quintile experienced a decrease. This is indicative of a decline in the progressivity of the tax system. This trend is reversed between 2007 and 2013 where the top quintile experienced a rise while the rest experience a fall in their relative tax shares, indicating an increase in progressivity. Note that, since the top quintile contributes around 78 percent of total tax payments the changes in their relative tax share strongly influences the overall trend in tax progressivity measured by the Suits index.

Hence, our two measures of tax progressivity reveal quite different trends in Australia since 2001. The tax progression measure indicates a declining trend in tax progressivity, while the tax distribution measure indicates a tax progressivity cycle. In particular, the two measures show opposite trends in tax progressivity from 2014. This difference is mainly due to the difference in methodological approach. That is, the tax progression-based approach estimates the adjusted elasticity of tax liabilities; meanwhile, the tax distribution-based approach calculates a progressivity index based on the relative share of tax liability to income across the income distribution. Arguably, the former is a local measure, while the latter is a more comprehensive measure as it takes into account the relative changes in tax liabilities across the income distribution. More importantly, the tax distribution metric is flexible, which allows us to conduct decomposition analysis so as to isolate the quantitative importance of the underlying forces behind trends in tax progressivity.

4.3 Determinants of tax progressivity

In this section, we examine factors that drive trends in tax progressivity using the tax distribution metric. By definition, the estimate of the Suits index depends on the evolution of tax liabilities relative to the evolution of the income distribution. The former is mainly driven by the design of the Australian income tax system and tax reforms, while the latter is mainly driven by income growth and how the economic gains are shared by Australians.[9]

4.3.1 Tax indexing

In Australia, income tax brackets/thresholds are not indexed to adjust automatically with rising incomes due to economic growth and inflation. In theory, the government should regularly adjust income tax brackets through discretionary changes, namely an "active" tax policy, so that the real burden of taxes is relatively unchanged. In practice, however, the Australian government often leaves the tax brackets unchanged from one year to another ("inactive" tax policy). As a result, the evolution of income distribution pushes more taxpayers into higher tax brackets and increases effective and marginal tax rates, resulting in higher tax liabilities. This phenomenon arising from the lack of indexation is known as "fiscal drag" or "bracket creep"

Bracket creep and progressivity. We now study how and to what extent bracket creep affects trends in tax progressivity in Australia. To do so we consider the period from 2013 to 2016 where there were no discretionary adjustments to the income brackets and marginal tax rates, namely an inactive tax policy period.

Table 4 reports the percentage of tax payers in each statutory tax bracket and the percentage of taxpayers who were eligible for maximum LITO, some LITO or no LITO. We find that the inactive tax policy disproportionately affects the percentage of taxpayers in different tax brackets, especially the ones on the lower end of the income distribution. There is a significant reduction in the number of individuals who are eligible for no income tax or LITO.

Table 4: Movements of tax payers across income tax brackets

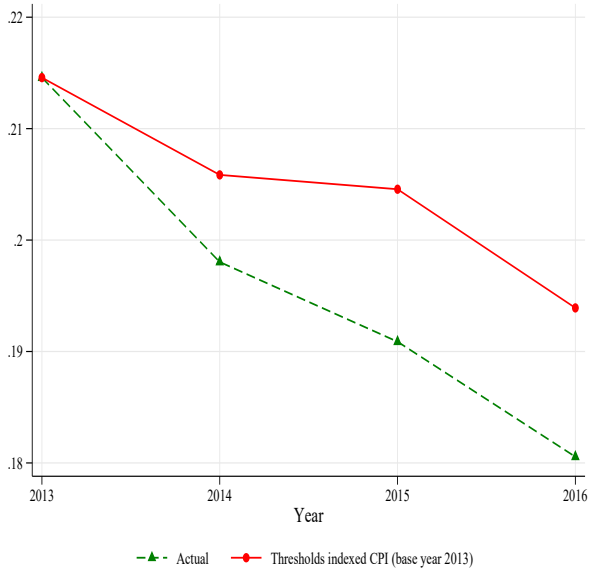
Brackets	2013	2016	Change
0 - 18,200	51.31	48.05	-3.27
18,201 - 37,000	10.10	10.20	0.10
37,001 - 80,000	23.09	23.68	0.58
80,001 - 180,000	13.21	15.07	1.87
Above 180,000	2.29	3.00	0.71
LITO: below 37,000	61.41	58.25	-3.16
LITO: 37,001 - 66,667	17.54	17.40	-0.14
LITO: above eligibility	21.05	24.35	3.30

Note: This table reports movements of tax payers between 2013 and 2016. There were no discretionary changes in income tax brackets and marginal tax rates during this period, which is referred as an "inactive" tax policy period. While holding the tax schedule unchanged the evolution of income distribution pushes taxpayers into higher tax brackets.

[9]The evolution of income distribution is driven by many factors, including productivity, business cycles, female labour force participation, population ageing, etc, which might have different effects on progressive levels of the tax system. In this analysis, we do not attempt to isolate which factors are the most important ones. Instead, we aim to better understand how and to what extent changes in the income distribution as a whole influences tax progressivity in Australia.

Specifically, the inactive tax policy effectively increases the number of taxpayers from the low and middle income groups. As seen in Figure 5 this policy subsequently leads to a declining trend in the Suits index from 2013 to 2016 (the green line). This implies that a bracket creep policy leads to a less progressive income tax system. This finding is rather surprising and contradicts a common view in the tax debate that bracket creep induces a more progressive tax system.

Figure 7: Bracket creep, CPI indexation and tax progressivity



Note: The red line is the Suits index for a hypothetical tax system in which income thresholds are indexed to inflation using the consumer price index (CPI). The green line is the Suits index for the actual tax system with no indexation. The income distribution is the actual one from our HILDA sample from 2013 to 2016.

Indexation to the CPI. In order to explore the effects of bracket creep on tax progressivity, we consider a counterfactual policy experiment where income thresholds of the income tax system were assumed to adjust annually by the consumer price index (CPI) since 2013. We simulate data for this hypothetical tax system and estimate the Suits progressivity index (the red line) in Figure 7. For comparison, we also report the results for the actual tax system (the green line).

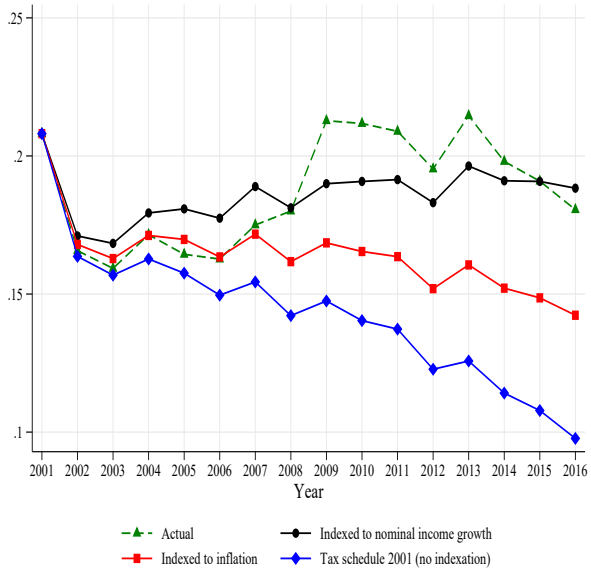
As shown in Figure 7 there is a similar downward trend in the Suits index with the counterfactual tax policy (the red line). However, levels of tax progressivity decline at a lower rate when the tax brackets are indexed to the CPI. Yet, this indexation system mitigates the decrease in the progressivity level of the Australian income tax system. However, it fails to anchor tax progressivity at the 2013 level. The main reason is that there are two drivers behind the shifts in income tax bases over time: inflation (nominal change in incomes) and economic/productivity growth (real change in incomes). The former is eliminated after indexing the tax brackets to the CPI, but the latter is still in play.

Indexation to nominal income growth. We now examine whether we could implement a more effective indexation system that would be able to maintain progressivity of the tax system. We consider an indexation system in which all tax brackets are indexed to nominal income growth. In particular, we assume all tax brackets are indexed to the CPI and average

real income growth rate.

Figure 8. reports trends in the Suits index from 2001 to 2016. The dashed green line is the Suits index for the actual income tax system with no indexation. The blue line with square markers is the Suits index for a hypothetical tax system with no adjustments to income tax brackets since 2001. The red line with square markers is the Suits index for a hypothetical tax system where all income thresholds are indexed to the CPI. The black line with circle markers plots the Suits index for a hypothetical tax system where all income thresholds are indexed to nominal income growth in terms of the average CPI and growth rate.

Figure 8: Indexation and tax progressivity



Note: The blue line (circle markers) is the Suits index for the 2001 income tax system with no adjustments to income tax brackets since 2001. The red line (square markers) is the Suits index for a hypothetical tax system where income tax thresholds are indexed to the CPI. The black line (triangle markers) plots trends for the tax system where thresholds are indexed to average growth in nominal pre-government income. The dashed green line is the one for the actual tax system with no indexation. The income distribution is the actual one from our HILDA sample from 2001 to 2016.

As seen Figure 8, the level of tax progressivity follows a downward trend if the tax schedule is left unchanged since 2001. This result is consistent with the previous finding that the bracket creep policy reduces progressivity of the income tax system. With an inactive tax policy that left the income tax schedule unchanged the evolution of nominal pre-government income distribution caused by inflation and higher productivity shifts tax burdens towards lower income groups. When the income tax schedule is indexed to the CPI (the red line with square markers), progressivity trend becomes more stable around the 2002 level until 2007 as the differences in progressivity levels are very small. The declining trend is mitigated after anchoring the nominal component of income growth. However, the progressivity level quickly deteriorated, especially after 2010. This result indicates that indexation to the CPI is not an effective tool to maintain a stable level of tax progressivity in periods when nominal income growth is subdued.

When the income brackets are indexed to both nominal and real components (black line with circle markers), levels of tax progressivity are lifted up to around the 2008 level, which is higher than the actual level in 2002, but closer to the actual levels since 2009. Notably,

there is still a marked divergence in the actual trends in tax progressivity (dashed green line) and the counterfactual trends with indexation to nominal income growth (the red line). These differences imply that active discretionary tax adjustments and real income growth are the main drivers of actual progressivity levels of the income tax system after 2007.

It is important to note that levels of tax progressivity are sensitive to which tax brackets are indexed. The reason is that income growth rates are not similar across income groups. A more effective policy option would be indexation of the tax brackets to income growth rates of a nearest income quintile. A thorough investigation of alternative scenarios of indexation is important; however, it goes beyond the scope of this analysis.

4.3.2 Tax components

The Australian income tax system consists of four core components: a standard income tax schedule (Standard Tax), low income tax offsets (LITO), senior Australian and pensioner tax offsets (SAPTO) and Medicare levy and surcharge (Medicare Tax). Since 2001 there have been a series of tax reforms that have affected different components of the income tax system. In this section, we examine how the reforms of each component of the tax system affect the tax liabilities and the overall level of tax progressivity over time. We do so by considering the tax liabilities for four hypothetical income tax systems: (*i*) The standard tax schedule exclusive of all other three components ("Standard Tax"); (*ii*) a combination of Standard Tax and LITO, (*iii*) a combination of Standard Tax and SAPTO and (*iv*) a combination of Standard Tax and Medicare Tax.

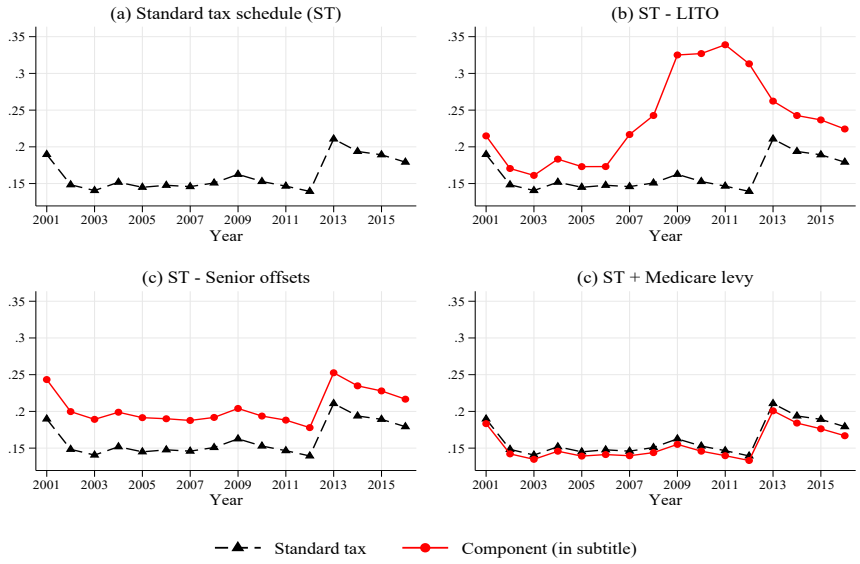
We calculate the Suits index for each counterfactual experiment and report the results in Figure 9. Panel (a) of Figure 9 plots trends in the counterfactual Suits index, assuming the Standard Tax at work. It is interesting to see that the Suits index is relatively stable from 2002 to 2012. This implies that the discretionary changes to the standard tax schedule only had a relatively small effect on the progressivity level. This result is rather surprising as there was a steady increase in the top threshold from $\$62,500$ in 2004 to $\$150,000$ in 2007. The most significant change in the progressivity level of the Standard Tax from 2012 to 2013 is an increase in the tax free threshold from $\$6,000$ to $\$18,200$.

The Suits index declines for any year when there were no changes in the Standard Tax from the previous year. As seen in Figure 9, there are two declining episodes in the tax progressivity trend between 2001 and 2003 and between 2013 and 2016. As discussed earlier, during these two sub-periods the tax policy are practically inactive with very little or no discretionary changes from one year to another.

Panel (b) of Figure 9 plots trends in tax progressivity for the counterfactual tax system that includes the Standard Tax and LITO. For all years, LITO reduces the tax liabilities of the low income individuals so that it has a positive effect on the overall level of tax progressivity. As seen in Panel (b), when LITO is subtracted from the standard tax schedule the Suits index increases. Interestingly, the changes to LITO, including a large increase in maximum offset amount and LITO thresholds, drive the upward trend in tax progressivity from 2006 to 2011. The maximum offset was reduced from $\$1,500$ to $\$445$ in 2013. However, the income test threshold for LITO was raised. The Suits index for LITO increased sharply between 2006 and 2011.

Subtracting all senior tax offsets (SAPTO) from standard tax schedule also reduces the tax liabilities of older individuals, which subsequently leads to higher levels of tax progressivity. Panel (c) of Figure 9 depicts an upward shift in trends in tax progressivity. In contrast, adding the Medicare Levy to the Standard Tax leads to a small reduction in the Suits index as depicted in panel (d). In general, the patterns in the Suits index trends in Panels (c) and (d), are similar to the one for the standard tax in Panel (a). However, the pattern for trends in the Suits index for the standard tax and that for LITO significantly different starting from 2006. This highlights the important role of LITO in determining the overall progressivity of the tax system since 2006.

Figure 9: Suits index for four hypothetical income tax systems



Note: There are four hypothetical income tax systems in consideration: (*i*) The standard tax schedule exclusive of all other three components ("Standard Tax"); (*ii*) a combination of Standard Tax and LITO, (*iii*) a combination of Standard Tax and SAPTO and (*iv*) a combination of Standard Tax and Medicare Levy. The income distribution is the actual ones from our sample of HILDA data. The tax liabilities are calculated from the hypothetical income tax system using the actual income distribution.

5 Extensions and robustness checks

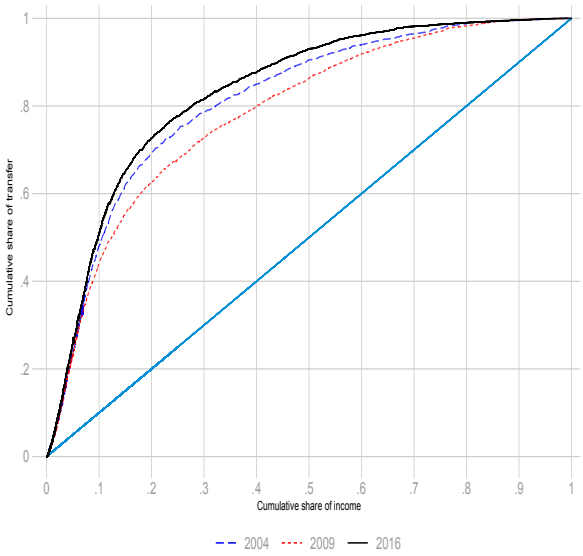
5.1 Government transfers and overall progressivity

In the previous section we have focused on progressivity of taxes only, but ignored government/social transfers. We now include government transfers and examine progressivity of the transfer system and then the tax and transfer system as a whole. In Australia, social transfer programs, including pension and family benefits, are means-tested, depending on household income and assets. We use data from our HILDA sample to analyse government transfers to households and their individual members.

Progressivity of the transfer system. We define transfers to be progressive if it decreases with income. We first plot the relative concentration curve to describe how progressive the Australian transfer system is. Figure 10 displays the relative concentration curves for gov-

ernment transfers, using data for 2004, 2009 and 2016, and the 45 degree line of proportionality where transfer shares equal income shares. The concave curves above the proportionality line indicate that social transfers are concentrated at the lower end of the income distribution, so that low income individuals receive a larger share of transfers. Specifically, the concentration curves for government transfer indicate that more than 60% and 90% of government transfers are allocated to the bottom 20% and 50% of income, respectively. In contrast, less than 2% of transfers are allocated to the top 20% of the income distribution. The transfer system is indeed very progressive in Australia. Compared to 2001, the transfer system is more progressive in 2016, while it is less progressive in 2009.[10]

Figure 10: Relative concentration curve for government transfers



Note: The relative concentration curve for government transfers plots the cumulative proportion of transfers ordered by income against the cumulative proportion of income. The 45 degree line indicates proportionality where transfer shares equal income shares. The Suits index is the area between the 45-degree line and the relative concentration curve for transfers. Technically, a progressive transfer system results in a negative Suits index. However, in order to compare between the Suits index for taxes and the Suits index for transfers in a consistent manner we transform the Suits index such that it is in terms of its absolute value. By doing so, an increase in the transformed Suits index for transfers implies an increase in progressivity.

The Suits progressivity index for government transfers can be calculated based on the area between the line of proportionality and the relative concentration curve. Technically, since transfers are negative taxes a progressive transfer system results in a negative value for the Suits index. In order to compare between the Suits index for taxes only and the Suits index for transfers only in a consistent manner we transform the Suits index for transfers such that it is in terms of its absolute value. Our Suits index for progressive transfers is positive after transformation. The Suit index is +1 for the most progressive transfers possible and takes the value zero for a proportional transfer. The closer the Suits index is to 0, the lower the progressivity of transfers.

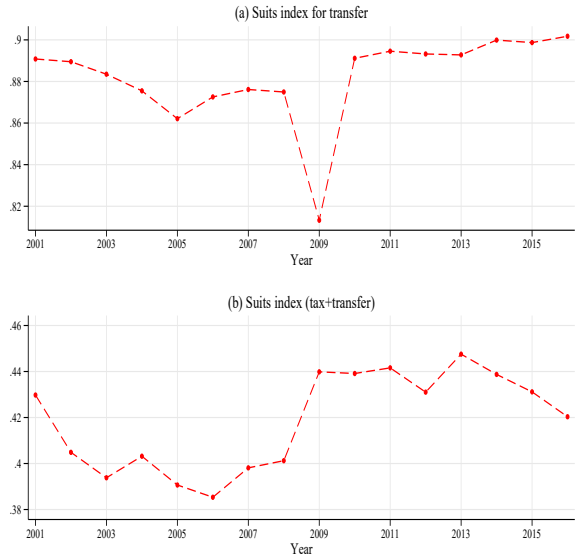
Panel (a) of Figure 11 reports the Suits index for social transfers. The Suits index confirms

[10]We provide more descriptive statistics of government transfers and post-transfer income in Table 10 in the accompanying technical appendix.

that the Australian transfer system is indeed very progressive with its value close to 0.9 in 2001. The progressivity level of the transfer system has been stable over the period, except for a drop in 2009. It is observed that the transfer system is slightly relatively more progressive in 2016.

Progressivity of the tax and transfer system. We now analyse the overall progressivity of combined taxes and transfers. Panel (b) of Figure 11 reports the trends in the overall progressivity of the tax and transfers system since 2001. The Suits index for combined taxes and transfers is a weighted average of the individual Suits indices where the weights are equal to the system's total revenue. From our sample, the tax system generates around $60-64\%$ of total revenue and the transfer system generates a negative $35-40\%$ of total revenue during the period. Thus the progressivity of the tax system dominates the overall progressivity of the tax and transfer system. However, adding transfers significantly increases the Suits progressivity index by around 0.2 points, compared to the Suits index for tax only.

Figure 11: The Suits index for transfer only and tax and transfer together



Note: The figure displays the Suits index for transfer only and the Suits index for tax and transfer together. The Suits index for transfers is transformed to have positive value, which is +1 for the most progressive transfers possible and takes the value zero for a proportional transfer. The Suits index for both tax and transfer is a weighted average of the individual Suits indices where the weights are equal to the system's total revenue.

5.2 Household heterogeneity, equivalence scale and progressivity

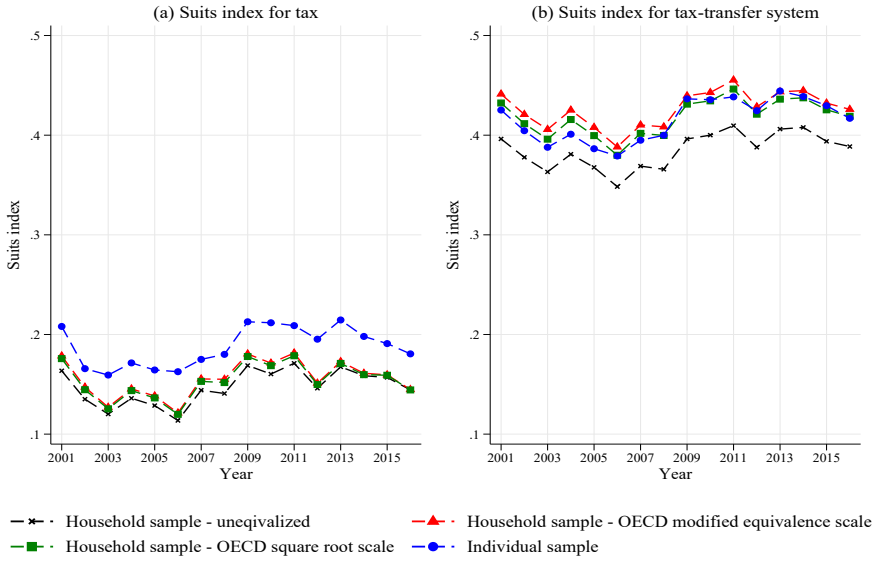
In Australia, all taxpayers are required to file their tax returns individually.[11] The income tax schedule is generally applied to all tax-paying residents. However, offsets, levies and concessions often depend on characteristics of a household that individuals belong to. That is, household demographics matter for the actual tax payments of household members. For example, the number of adults and children, and their age and relationship affect tax liabilities of each individual member. The medicare levy and medicare levy surcharge amounts differ based on whether one is in a relationship and in terms of the number of dependent children. Similarly,

[11] Differently, taxpayers have options to file their taxes individually or jointly in the US and many other OECD countries.

family benefits and tax offsets depend on the household composition and size.

We now study to the extent to which the family-related tax policies would change progressivity of the income tax system. We take into account household characteristics that allow adult individual members of a household to reduce their tax payments. In addition, we deviate from individual as the tax-paying unit and assume that the household is the tax-paying unit. In order to control for household size we use the OECD modified equivalence scale from Organisation for Economic Co-operation and Development (2013). This scale basically assigns a value of 1 to the first adult, of 0.5 to each additional adult and of 0.3 to each child below 15 years of age. We compute equivalised household incomes and tax liabilities based on this scale and re-calculate the Suits progressivity index for tax, using the household level data. [12]

Figure 12: Trends in tax progressivity with different income equivalence scales



Note: The figure reports differences in Suits indices for the tax system in panel (a) and the overall tax-transfer system in panel (b) using the individual sample and household sample with various equivalisation assumptions. The OECD modified equivalence scale (red line, triangle marker assigns a value of 1 for the first adult, 0.5 to each additional adult and 0.3 to each child below 15. The square root scale (green line, square marker takes the square root of total individuals in each household.

Figure 12 reports trends in the Suits index from the household sample. For comparison, we also report the Suits index previously estimated from the individual sample. Our results indicate that the Suits index for tax generated from the household sample is relatively lower than the one from the individual sample; however, both of them have a very similar pattern of the tax progressivity cycle. In contrast, the overall tax-transfer progressivity is less sensitive to whether we use individual data or household level data. We conclude that accounting for household demographics scales down the level of tax progressivity, while maintaining the overall trend. Thus, the progressivity cycle is robust to the change in unit of measurement. Similarly, tax progressivity is fairly robust to the two equivalence scales that are examined. In fact, using unequivalised data yields very similar results to using equivalised household data when it comes

[12] The summary statistics of the HILDA household level data are available in Table 11 in the accompanying technical appendix.

to tax.

5.3 Progressivity and redistribution

In this section we extend our analysis to examine implications of the progressive tax and transfer system for income inequality in Australia. For the sake of consistency with related literature, we adjust for the number of adult and children in each household using the modified OECD scale[13].

Measuring income inequality and redistribution. There are several different indicators of inequality that are typically used in the literature. The most commonly-used measure of inequality is the Gini coefficient, which is derived from the Lorenz curve. The Gini coefficient has value between 0 to 1, where 0 represents perfect equality and 1 represents complete inequality. In this section, we simply use the Gini coefficients for pre-government income and post-government (after-tax and -transfer) income to assess the extent of redistribution that the progressive tax and transfer system induces.

Panel (a) of Figure 13 plots the trend in the Gini coefficient[14] for pre-government (before tax and transfer) and post-government income (after tax or after transfer or after tax and transfer). Trends in pre-government income inequality has been relatively stable during the period. Inclusion of progressive taxes leads to a reduction in post-tax income inequality as the Gini coefficient for after-tax income is lower than that for pre-government income. However, there is a larger reduction in the Gini coefficient for after-transfer income. This implies the transfer system plays a more important role in the redistribution of income from rich to poor individuals. The progressive tax and transfer system significantly reduce income inequality in Australia. Reynolds and Smolensky (1977) measures the difference between Gini coefficients for pre-government income and post-government income to formulate a redistribution index that measures the redistributive effect of the tax and transfer system.

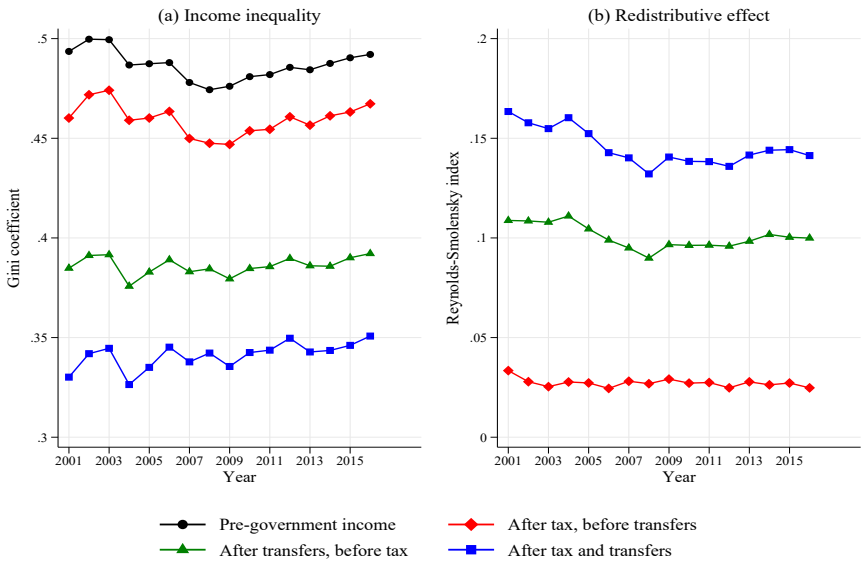
Panel (b) of Figure 13 displays the Reynolds-Smolenksy redistribution index for tax and transfers. As observed in Panel (b), the Reynolds-Smolenksy index indicates that the redistributive effect of progressive taxes is smaller than that of progressive transfers. The overall redistributive effect of the tax and transfer system is relatively smaller from 2001 to 2008. Similarly, the redistributive effect of the transfer system is declined during the period. This was followed by a steady increase till 2015. In contrast, the redistributive effect of the tax system remained fairly steady from 2001 to 2016.

Herault and Azpitarte (2015) examine trends in the redistributive impact and progressivity of the tax and transfer system between 1994 and 2009 using the Australian Survey of Income and Housing Costs (SIHC). They find that after reaching a peak value in the late 1990s, the redistributive effect of the tax and transfer system declined sharply. Having used a different dataset, we confirm that the redistributive effect follows a declining trend in early 2000s, but this trend slightly reversed after 2008.

[13]We find that in contrast to the Suits index, the Gini coefficient and the Reynolds-Smolensky index is highly sensitive to the equivalence scale used for the data.

[14]Our estimates of the Gini coefficient are slightly higher than estimates using HILDA data cited in similar literature. This is because we include irregular income as well as regular income. In addition, we drop observations with inconsistent values for tax liability. We report our Gini estimates in Section 6.3 in the technical appendix.

Figure 13: Income inequality and the redistributive role of the tax and transfer system

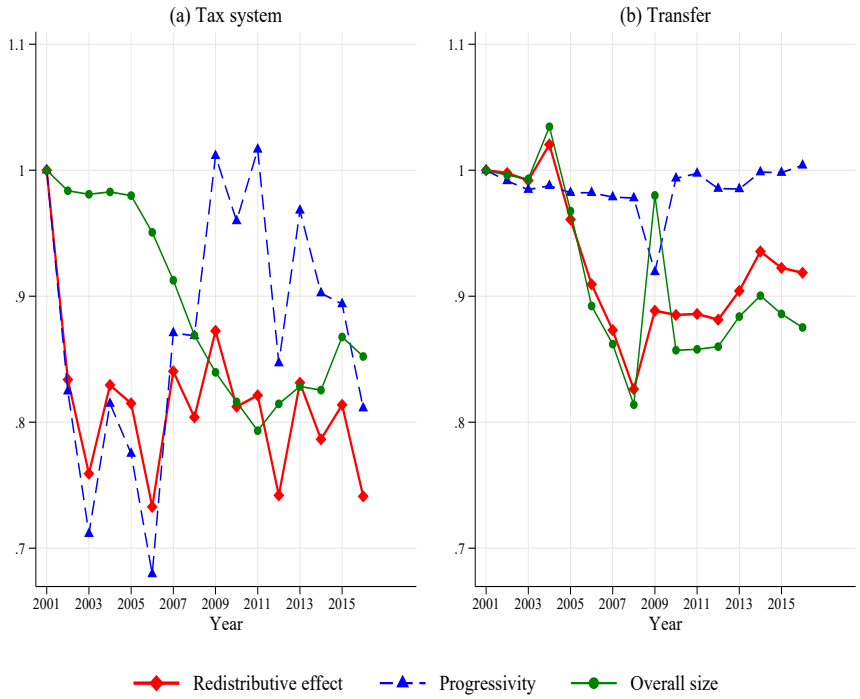


Note: Panel (a) displays trends in income inequality measured by the Gini coefficients for pre-government and post-government income. Pre-government income is a sum of incomes from labor and capital market activities and private transfers. Post-government income consists of post-tax, post-transfer, and post-tax and transfer income. Panel (b) reports the redistributive effects measured by the Reynolds-Smolenksy index.

Progressivity and size of the tax and transfer system. It is important to note that progressivity is but one component of the redistributive effect. As per Lambert (1985), the redistributive effect is explained by the progressivity of the tax system and the transfer system and their respective sizes as measured by average tax and transfer rates. Aronson, Johnson and Lambert (1994) shows that in the presence of horizontal inequality, the redistributive effect must also be corrected for the presence of re-ranking. The effect of re-ranking caused by the net fiscal system can be measured by the difference between post-government Gini coefficient and the concentration coefficient of post-government income using the pre-government rankings. This is known as the Atkinson-Plotnick re-ranking index (Atkinson, 1980). Individual level data from HILDA shows a fairly small re-ranking effect for the tax-transfer system with an average Atkinson-Plotnick index of around 0.02 with a between year standard deviation of 0.002. Hence, we rule out any large effect on redistribution from re-ranking and focus on the size and progressivity of tax and transfers.

We explore how each of these factors contributes to trends in redistribution by examining co-movements. As such, we compare co-movements in progressivity, size and redistributive effect of the Australian tax and transfer systems separately. Our focus is less on the level and more on the year on year movement in the trend. Hence, for ease of exposition, we normalize the relevant metrics for each year by their 2001 values. This is illustrated in Figure 14.

Figure 14: The role of tax and transfer progressivity and their size in the redistributive effect



Note: The figure reports the role of progressivity and size of the tax and transfer system in overall redistribution.

Panel (a) of Figure 14 plots these co-movements for the tax system. Trends in progressivity and the redistributive effect of the tax system moved together while the trend in size of the tax system generally moved in the opposite direction. In this regard, between 2001 and 2003, there was a steep decline in both progressivity and the redistributive effect while tax size remained relatively constant. Between 2006 and 2009 progressivity and redistributive effect sharply increased while there was a sharp downward trend in tax size.

Panel (b) of Figure 14 plots the normalized trends for the transfer system. In contrast to the tax system, trends in the redistributive effect of transfers was less driven by trends in transfer progressivity, which remained relatively stable for most of the period. Rather, changes to the overall size of transfers had a large impact on the redistributive effect. For instance, a significant decline in the average size of transfers from 2004 to 2008 lead to a sharp decline in the redistributive effect. The progressivity of the transfer system was relatively stable for most of the period except between 2008 and 2010. There was a significant decline in the progressivity of the transfer system from 2008 to 2009. This was countered by a large increase in the average size of transfers which in turn increased the redistributive effect.

In summary, our exploratory analysis shows that tax progressivity plays a crucial role in the redistributive effect of the overall tax-transfer system. Between 2001 and 2016, trends in tax progressivity heavily affected trends in the redistributive effect of income tax. However, any effect from the tax system on overall redistribution is small in comparison with the effect from the transfer system. During the period, the redistributive effect of the transfer system was governed less by its respective progressivity, and more by the size of transfers.

This finding provides an insight to the debate on tax progressivity and its impact on income inequality. The key point is that the progressive tax system alone has limited role; meanwhile,

the size and structure of the transfer system had played a central role in redistribution in Australia during the period.

6 Conclusion

This paper makes two contributions. First, we characterize the distributions of income and tax liabilities in Australia since the introduction of Goods and Services Tax Act, using household survey data from HILDA and administrative data from the ATO individual tax sample. We calculate effective average and marginal tax rates that individuals face, and also discuss how the income distribution and taxes have changed. Second, we provide a comprehensive analysis of progressivity of the Australian personal income tax system since 2001.

We formulate two metrics for measuring tax progressivity. The first one measures tax progressivity in terms of tax liability progression at a given income level, i.e., the elasticity of tax with respect to income (Tax progression measure). The second one relies on the distribution of tax liabilities relative to the distribution of income (Tax distribution measure). Our estimates of these two measures show trends in tax progressivity that are quite different. The tax progression measure indicates a declining trend in tax progressivity. Meanwhile, the tax distribution measure indicates a cycle of tax progressivity. This difference is mainly due to the difference in methodological approach. The tax progression measure intuitively estimates the elasticity of tax liabilities, while the tax distribution measure calculates the relative share of tax liability to income.

We conduct a number of counterfactual analyses to identify factors behind changes in the levels of tax progressivity using the tax distribution measure. We find that the lack of a proper indexation system has a negative effect on the tax progressivity trend in Australia. Bracket creep pushes more tax payers into higher tax brackets as the income distribution evolves. Discretionary adjustments to income brackets are necessary to maintain tax liabilities relative to changes in the income distribution due to inflation and economic growth. Without active changes in tax policy from one year to another, the progressivity of the tax system declines. Indexing tax brackets to the CPI partially mitigates the decline in tax progressivity; however, it fails to account for real income growth. We identify two sub-periods of in active tax policy, between 2001 and 2003 and between 2013 and 2016, that result in a significant decline in tax progressivity. In addition, we find that the increase in generosity of the Low Income Tax Offset contributed most to the increase in tax progressivity from 2006 to 2009.

We extend our main analysis of tax progressivity with an exploratory examination of the overall tax-transfer system. This helps in contextualizing tax progressivity within the wider net fiscal system. In this regard, the key finding is that the role of the transfer system outweighs the role of the tax system in the overall redistributive effect. Thus, tax progressivity had a limited role in mitigating income inequality. In contrast, redistribution was most affected by changes to the the average size of transfers. For most of the period, the progressivity of the transfer system remained relatively stable. Nevertheless, despite its limited effect in overall redistribution, tax progressivity played a crucial role in the redistributive effect of the tax system. In that, trends in the redistributive effect of the tax system closely follow trends in tax progressivity.

Finally, we highlight the quantitative importance of accounting for household heterogeneity

when measuring tax progressivity using household survey data. The magnitude of the Suits index is sensitive to whether it is calculated using individual data or equivalised household data. Taxes and transfers depend on age, family structure and a large variety of other factors. In addition, since the Suits index is independent of the size of the tax system, it can be used for international comparison of tax progressivity across countries. We leave these issues for future research.

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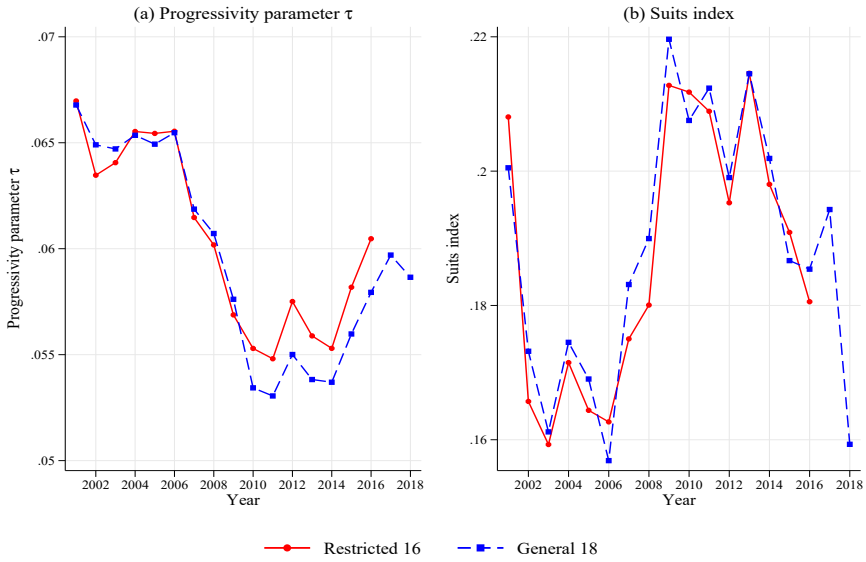
Appendix

HILDA: The unconfidentialised vs. confidentialised releases

There are two versions of HILDA: the General (confidentialised) release and the Restricted (unconfidentialised) release which contain more detailed information than the General release, including date of birth, postcodes of residence, and non top-coded income and occupation. In the paper we report the results from the Restricted release 2001 - 2016.[15] In this section we compare the results from the two releases. Figure 15 plots the two metrics for measuring tax progressivity from the General release 2001 - 2018 (dashed blue line) and the Restricted release 2001 - 2016 (red line). Our results indicate that the patterns of tax progressivity trend are fairly similar even though there are differences in the levels of tax progressivity. Moreover, the estimates of the two metrics from the General (confidentialised) release show a sharp decline in the levels of tax progressivity from 2017 to 2018. Panel (b) shows that the cyclical trend in the Suits progressivity index is more pronounced when including the estimates for 2017 and 2018.

Figure 15: Tax progressivity: General vs. Restricted release



Note: The figure compares trends in tax progressivity using two versions of HILDA: the General (confidentialised) release 2001 - 2018 (dashed blue line) and the Restricted (unconfidentialised) release 2001 - 2018 (red line). Panel (a) plots the curvature parameter τ (tax progression metric), while Panel (b) plots the Suits progressivity index (tax distribution metric).

ATO data: Description and summary statistics

ATO unit record data contains 1% sample of records for $2004-2011$ and 2% sample of records for $2011-2016$.[16] The samples are selected pseudo-randomly. The units are confidentialised. In that, the top and bottom 1% of each data item is top (or bottom) coded. This is done by creating between one and three cohorts in these top and bottom 1% ranges and each record in that cohort is assigned the average of all records in that cohort for that particular data item.

[15] We currently are in the process of obtaining the unconfidentialised version of HILDA for 2017 and 2018.

[16] The change in the sampling size does not affect the composition of the sample as the sampling method has been consistently applied on all years.

Table 5: Summary statistics for ATO data in 2016

Quantile	Pre-gov income			Tax			Relative share	Tax rate	
	Mean	Share	Cumulative	Mean	Share	Cumulative	Tax share/Income share	Marginal	Average
Decile 1	5,721.35	0.91	0.91	0.18	0.00	0.00	0.00	0.00	0.00
Decile 2	17,839.45	2.83	3.73	13.68	0.01	0.01	0.00	0.09	0.00
Decile 3	26,869.51	4.26	7.99	800.70	0.60	0.61	0.14	0.19	0.03
Decile 4	35,888.03	5.68	13.67	2,454.06	1.84	2.45	0.32	0.24	0.07
Decile 5	44,429.74	7.04	20.71	5,299.62	3.97	6.41	0.56	0.32	0.12
Decile 6	53,760.50	8.51	29.22	8,587.03	6.43	12.84	0.75	0.32	0.16
Decile 7	65,067.75	10.31	39.53	12,394.41	9.28	22.11	0.90	0.32	0.19
Decile 8	79,557.49	12.60	52.13	17,164.47	12.85	34.96	1.02	0.35	0.22
Decile 9	102,141.99	16.18	68.31	25,072.23	18.76	53.72	1.16	0.37	0.24
Decile 10	200,087.66	31.69	100.00	61,832.74	46.28	100.00	1.46	0.41	0.29
Top 1%	493,875.63	7.82	100.00	181,755.81	13.60	100.00	1.74	0.47	0.36

Note: The table reports the descriptive statistics of income and tax liabilities from ATO data in 2016. Column (1) lists the mean nominal pre-government income for each quantile. Column (2) presents the share of total pre-government income earned by the quantile and column (3) shows the cumulative shares. Columns (4) to (6) repeats the same statistics by quantile for tax payment/liability. Column (7) reports the share of tax liability for each quantile relative to their share of income, namely, Relative Share of Tax (RST). Columns (8) and (9) presents the marginal and average tax rates averaged by quantile.

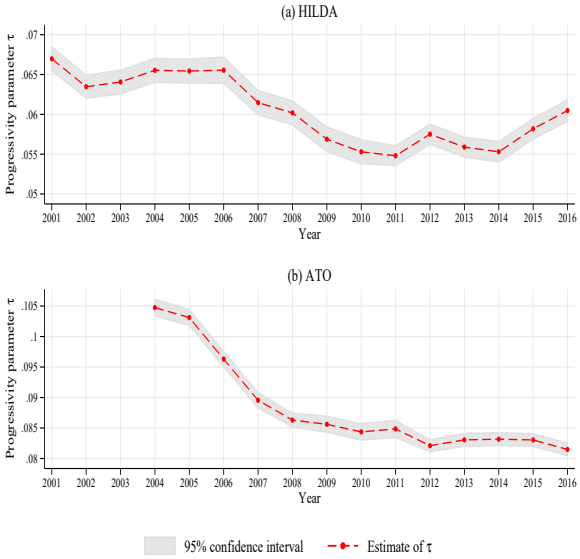
The ATO sample used in this paper contains $2,071,348$ units in total and includes 49 variables that provide useful information on demographics and individual components of net income. The large size of the sample enables more precise estimations of mean values and distributions for total income and its respective income components. However, it is important to bear in mind that the sample only includes those who have lodged a tax return and thus, reported values are not reflective of the entire population. Specifically, the samples drawn from the dataset would be biased towards top income earners and would not include those who earn very little to no income that have no incentive to lodge a tax return. In addition, tax data does not include complete information on all components of income, especially public transfers that are non-taxable. This implies that total income calculated from tax data might not be reflective of actual total income inclusive of all components.

The sample of ATO data does not contain any information on the actual or estimated tax paid by individuals. We impute the amount of tax paid, the average tax rate and the marginal tax rate instead of actual values, using a similar method and codes used to impute tax liabilities in HILDA. Further, information on family structure included in the data is insufficient to accurately estimate tax payments. For instance, there is no information on the number of children and the only information on partner status is a variable that records whether or not a spouse's details such as the date of birth were reported. Hence, levies and offsets that depend on the number of children and partner status are all estimated using the rate for an individual without any dependent children. This results in an approximate estimate of tax payments and tax rates. Nevertheless, trends in progressivity indices are consistent with results obtained from the HILDA sample.

Table 5 reports the descriptive statistics of income and tax liabilities across the income distribution in 2016 using ATO data. All additional descriptive tables and stylized facts on the distribution of income and tax liability over time from 2004 to 2016 are in the online technical appendix.

Tax progressivity: Estimates from ATO data

Figure 16: Tax progressivity measured by the curvature parameter τ

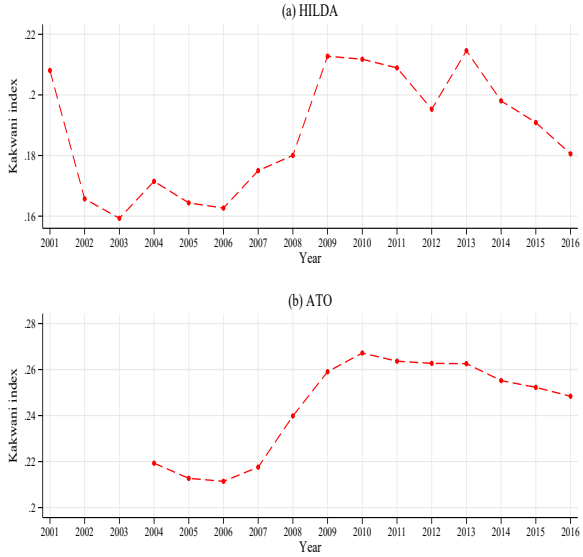


Note: This figure shows the estimates of the curvature parameter τ from 2004 to 2016 using ATO data compared with estimates from 2001 to 2016 using HILDA data, where $\tau = \frac{m(y)-t(y)}{1-t(y)}$.

Figure 16 displays the estimates of τ and along with the 95% confidence interval using ATO from 2004 - 2016. As shown in Panel (b), there is a declining trend in τ since 2004. Moreover, the trend from ATO data is more pronounced than that from HILDA. The decline in τ implies that the gap between marginal tax rates and average tax rates has been narrowed down. The main reason is that while the marginal tax rates at the very top of the distribution have not increased by much over the period, the rates at lower quantiles (particularly at the middle) have increased due to the increases in income tax thresholds. The steepest decline in τ is observed between 2005 and 2008 during which the top income threshold was increased substantially resulting in only the top 1 percent paying the top marginal tax rate. Thus, according to this tax progression measure the progressivity level of Australia's personal income tax system, on average, has declined since 2004.

The trend in tax progressivity estimated from ATO data is smoother than the one estimated from HILDA. Most noticeably, the estimates from HILDA data indicate a slightly upward trend while the ones from ATO shows a decline since 2014. This is mostly due to differences in the availability of demographic information between the two samples. Tax liabilities for ATO are estimated ignoring the effect of family structure, while tax liabilities in the HILDA sample take in to account a whole range of demographic information such as the number of dependents enables us to examine the impact of the changes in the income distribution for the subsequent years if a given tax schedule is left unchanged since the first year that indents, age of dependents and marital status. These information are crucial in the calculation of various offsets that reduce tax liabilities.

Figure 17: Tax progressivity measured by the Suits index



Note: Panel (a) reports the estimates of Suits index, using HILDA data from 2001 to 2016. Panel (b) reports the same using ATO data from 2004 to 2016.

Figure 17 reports the estimates of the Suits progressivity index using ATO data from 2004 to 2016. Our estimates confirm that there is a tax progressivity cycle, which has a similar pattern to the one previously estimated from HILDA data. That is, there are a modest decline from 2004 to 2006, then a sharp increase until 2010, and a slight decline thereafter. It appears that the tax progressivity cycle estimated from ATO data is smoother than the one estimated from HILDA.