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Do couples bunch more? Evidence from partnered and single taxpayers

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Abstract
Recent papers hypothesise that estimates of the elasticity of taxable income (ETI) for individuals may be underestimated where those individuals are taxed separately but are part of a couple. This paper investigates that issue by applying the 'bunching at tax kinks' approach to estimate separate ETIs for partnered and single individuals. It shows that there are opportunities for, and constraints on, bunching specific to partnered individuals. Using administrative taxable income data for the New Zealand taxpayer population over the period, 2000 to 2017, taxpayers are matched to their partners using population census data. Results strongly support the hypotheses that ETIs are larger for partnered, than for single, individuals, and where both partners are located in the same income tax bracket. Couples where one (and especially where two) partners are self-employed reveal particularly large elasticities.

Keywords Elasticity of taxable income · Bunching estimates · Couples

JEL Classification H26 · H31

1 Introduction

The elasticity of taxable income, ETI, measures the responsiveness of taxable income to changes in the marginal net-of-tax rate. It is widely used in assessing behavioural responses to taxation because it summarises a range of different types of response in one measure. These include labour supply, various forms of income shifting, and evasion.[1] In defining the elasticity, a prerequisite is the choice of

[1] Saez et al. (2012) survey earlier empirical ETI literature; Kleven (2016) reviews the bunching approach.

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income unit and population group. In some countries, such as the US, Germany, and Denmark, married couples are taxed jointly, which means that income splitting occurs and both partners face a common marginal tax rate. Empirical ETI studies of those countries therefore treat the family as a single taxpaying unit. In countries, such as Australia, Canada, the UK, and New Zealand, which tax on an individual basis, the individual is the natural income unit to use in ETI estimation.[2]

In cases where married or partnered individuals are taxed separately, the possibility that a joint decision process may be involved has generally been ignored.[3] This is partly explained by the absence of taxable income data on partners within a family when tax is based on individual incomes. This can occur even where administrative data are available, since partner information is not normally required to calculate the tax liability of each individual.

Some ETI studies have distinguished between single and married taxpayers. Bastini and Selin (2014), using data for Sweden (where individual filing applies), found differences between single and married individuals though their sample decomposition cannot explore how a change in the tax rate facing one partner may affect the taxable income of both partners.[4] A recent meta-analysis by Neisser (2021a, 2021b), covering 1,720 ETI estimates from 61 studies, does not find statistically significant ETI effects of marital status. Using probit analysis and data for Ecuador, Bohne and Nimczik (2017, p. 13) report that 'women and married individuals are more likely to bunch'.

A rare empirical study which examines within-couple responses is Gelber (2014). He adds terms involving changes in a married partner's income and tax rate to the standard ETI regression specification, using Swedish data. However, this analysis excludes non-married and single-person households. The possibility of different responses by individuals and couples is examined theoretically by Creedy and Gemmell (2020) who show that, where couples maximise a joint utility function, ETIs for individuals within couples can be expected to be underestimated if intra-couple relationships are ignored.

The present paper uses a unique dataset for the population of New Zealand taxpayers, and reports ETI estimates obtained by matching individuals' tax return data

[2] Seventeen OECD countries use pure individual taxation. Four (France, Luxembourg, Portugal and Switzerland) use pure joint earnings taxation. In the Czech Republic, Iceland, the Netherlands, Norway, Poland and Spain, the individual is the tax unit but joint taxation is possible for certain types of income: see OECD (2006) for details.

[3] Microsimulation models of labour supply invariably assume joint decision-making, but comparisons of different tax regimes are rare. Bach et al. (2013) compare effective tax rates in the UK and Germany, showing how incentives are affected by income splitting. Bick and Fuchs-Schündeln (2017) use behavioural microsimulation to compare 17 European Countries and the US, finding that tax treatment of couples plays an important role in explaining differences. Kleven et al. (2009) examine optimal income taxation of couples making joint labour supply decisions, which they test empirically via a microsimulation for the UK.

[4] Indeed, an increase in the tax rate facing a high-income partner may induce an increase in the taxable income of the lower-income partner who faces an unchanged lower marginal rate. Chetty et al. (2011) examine the effect of earned-income tax credits on taxable incomes of sole parents and married couples but do not investigate the types of intra-couple response discussed here.

within families over three periods around New Zealand census years when family-related information is available. Following an extensive matching exercise, Inland Revenue data were combined with census data, using the Integrated Data Infrastructure (IDI) maintained by Statistics New Zealand.[5]

This allows testing of the hypothesis that ETIs for individuals in couples are larger than those for single individuals, and provides estimates for different family types, depending on each partner's income source. In addition, the question is examined of whether incentives for income sharing can be expected to differ between members of couples where each partner is observed to earn income in a different tax bracket, compared with the case where partners are observed in the same bracket. Using various sample decompositions, and the bunching approach to ETI estimation, the paper also examines how far ETI estimates differ between individuals with bunching or non-bunching partners, and examines differences in the forms of income earned by, and tax elasticities of, different types of couple.

Estimation of the ETI gives rise to substantial challenges, because most estimation methods rely on longitudinal information on income changes of individuals over time. They need to separate 'treated' from 'non-treated' groups, and must find suitable instruments to deal with endogeneity, arising because the marginal tax rate and taxable income are jointly determined. The estimation method adopted here is the bunching estimator proposed by Saez (2010) and Chetty et al. (2011). This circumvents some of the estimation challenges facing regression methods applied to longitudinal data, by exploiting the fact that taxpayers are often observed to bunch at income thresholds, or tax kinks, above which the marginal tax rate increases.[6] An advantage of this approach is that there is a direct proportional relationship between the elasticity and the extent of observed bunching; see Kleven (2016). In addition, the bunching-based estimates can be obtained using cross-sectional data and for a variety of income thresholds and years, rather than relying on periods when tax reforms took place. Applications of bunching methods to ETI estimation include le Maire and Schjerning (2013), Bastani and Selin (2014), Paetzold (2019), Bertanha et al. (2019), Bosch et al. (2019), Gelber et al. (2020), Bergolo et al. (2021) and Alinaghi et al. (2021).

The results presented here provide strong support for the various couple-related hypotheses put forward. First, there is clear evidence that partnered individuals have markedly higher elasticities than equivalent single individuals. Second, this is especially pronounced where both partners earn income in the same tax bracket, and where at least one partner is self-employed. Third, for self-employed taxpayers who are part of a couple where both are self-employed, the ETI is significantly larger than when taxpayers are partnered with a wage-earner. Fourth, among wage-earners who are part of a couple, if the taxpayer is partnered with a self-employed individual, the estimated ETI for such wage-earners is larger. It is suggested that this

[5] "Appendix 2" provides details.

[6] However, bunching need not necessarily be observed; for example due to optimising frictions; see Chetty et al. (2011). Further, Blomquist and Newey (2017) and Bertanha et al. (2019) discuss ETI identification issues using bunching methods.

may arise from a tendency for many self-employed taxpayers in couple families to employ their partner as a wage-earner, giving them considerable discretion over wage levels and tax responsiveness.

Section 2 begins by considering the special characteristics of bunching in the context of couples, paying attention to whether individuals in couples are in the same or different tax brackets. The New Zealand income tax structure and the matched dataset are described in Sect. 3. The empirical method and main results are presented in Sect. 4. Results for various sample decompositions are then reported in Sect. 5, and brief conclusions are in Sect. 6. Three appendices provide further details.

2 Bunching by couples

For partnered individuals, there are opportunities for, and constraints on, bunching that are not available to single individuals. In addition to the opportunities for labour supply and income shifting (across time and tax codes) available to all taxpayers, partners can often benefit from a lower joint tax liability via intra-couple income sharing where they would otherwise be in different tax brackets. This may represent additional tax evasion opportunities or simply increased legal tax planning options by ensuring that family income that can be allocated at the discretion of the taxpayer is earned by the lower-taxed partner. In addition, couples can make coordinated adjustments in their individual labour supplies in response to a higher tax rate for one of them, to compensate for any loss of earnings by the partner responding directly to the higher rate.

For couples, adjustment costs of responding to a kink are effectively lower than for equivalent individuals not in a partnership. As Gelber et al. (2020) demonstrate, lower adjustment costs generate greater bunching by taxpayers above, but close to, the kink compared to the case of higher adjustment costs. In the case considered here, if couples can more easily shift income due to lower adjustment costs, it implies greater bunching for partnered individuals close to the kink compared to equivalent singles.

The ETI and tax compliance literatures have recognised the ease with which self-employed, compared to wage earners, can respond to marginal tax rate changes, due to more limited third-party reporting for the self-employed.[7] Self-employment also provides low-cost bunching opportunities for couples, via joint ownership of family businesses, or the employment of family members within the business either as wage-earners or as business partners.

Joint labour supply decisions and income reallocation options provide enhanced opportunities to share income within couples that are not available to single wage-earning or self-employed taxpayers. It suggests that partnered individuals where at least one partner is self-employed might be expected to display higher ETIs. Further, where a self-employed individual employs a wage-earning partner, there are

[7] See Slemrod (2007), Kleven et al. (2011), Slemrod and Weber (2012), Pomeranz (2015), Gillitzer and Skov (2018).

greater opportunities to share income between the two (since there is a high degree of discretion in wage-setting) and hence for larger bunching by those wage-earning partners compared with single wage-earners or those in a couple where both are employees of unrelated employers.

Furthermore, as Creedy and Gemmell (2020) show, if partnered individuals maximise a joint utility function and earn income in different tax brackets, when the higher tax rate changes, a higher ETI is expected for the more highly-taxed individual (than an equivalent single taxpayer), with a negative ETI for the lower-taxed partner.[8] The implications of joint utility maximisation for bunching behaviour are considered in the following subsection.

2.1 Joint utility maximisation and bunching

With joint utility maximisation, greater bunching from above the kink by the higher-income taxpayer is expected, together with the possibility of bunching from below by the lower-income partner. These responses may be labour supply related with couples coordinating their joint earnings decisions, or may involve pure income shifting designed to reduce joint tax liabilities, or some combination. Based on the well-known diagram illustrating bunching by individual taxpayers at tax kinks used by, for example, Saez (2010), Chetty et al. (2011) and Kleven (2016), Figs. 1 and 2 show the case for two partnered individuals' choices over taxable income, z, and consumption (after-tax income), c.[9] The standard individual case is captured in Fig. 1, which shows how a single marginal buncher, B, faced with an increased tax rate from t_1 to t_2 above the tax threshold z_T, would shift from an initial position at K with $z = z_{B_0} > z_T$, to the kink at M where $z_B = z_T$.

Suppose taxpayer B is partnered with taxpayer A, such that the couple maximise total utility associated with a joint utility function. Given differences in the partners' abilities and consumption/work preferences, they can be expected to locate at different points in (c, z) space, thus yielding different individual contributions to the household's total consumption and work hours/taxable income.[10] Each partner's indifference curves in Figs. 1 and 2 can therefore be thought of as being associated with joint optimisation, and thus a level of total utility of the couple: the figures illustrate an outcome where $z_A < z_T < z_B$. As a result, any change in the location by one partner in (c, z) space potentially affects the position and slope of the other

[8] Creedy and Gemmell (2020) show that this joint effect for couples is greater, the larger are the couple's individual elasticities via a term involving $(\eta_1 \eta_2)^2$ for individuals 1 and 2.

[9] This diagram is variously presented in consumption/hours-worked space (Chetty et al. 2011) or, as here, in consumption/income space (Saez 2010; Kleven 2016).

[10] Unlike the case of a single taxpayer maximising utility from c and z, those individual partner (c, z) contributions to total c and z do not necessarily imply either equal consumption sharing or that each partner consumes their respective contributions (c_A, c_B) to the household's total consumption possibilities. For example, partner A, who works h_A hours and earn c_A after-tax income need not be assumed to consume c_A of the household's total consumption, depending on sharing arrangements.

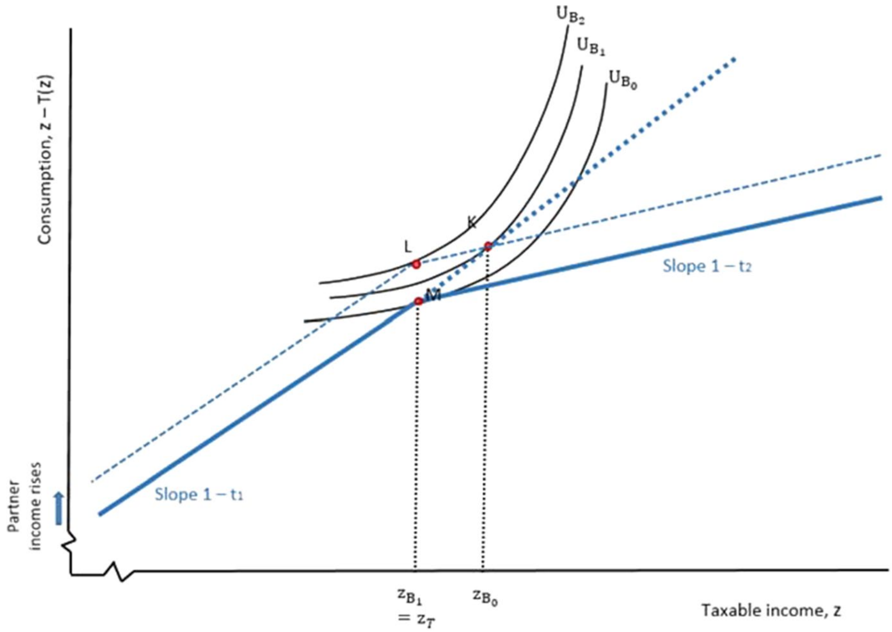

Fig. 1 Income-consumption choices: partner B

partner's indifference curves.[11] If individual A were partnered with a different individual than B, their respective indifference maps would potentially be positioned differently, generating different optimal outcomes.

Creedy and Gemmell (2020) demonstrate that, for the case where the joint optimisation process involves two partners initially locating either side of the new tax threshold, an increase in the tax rate facing the higher earner can be expected to lead to a reduction in taxable income of this partner in standard fashion (that is, a positive elasticity of taxable income, ETI). However, there is an associated increase in taxable income of the lower earning partner—a negative ETI—via a cross-price (income) effect from the partner's tax rate change. Of course, this need not necessarily imply bunching at the tax kink, z_T, by the lower earner. Whether this leads to bunching from below at z_T depends on the initial location of each partner, the position and slope of the respective indifference curves, and whether resulting income changes represent real behavioural (such as labour supply) changes or simply income shifting between partners.

The relevant analysis of responses to a new higher tax rate when taxpayer B is partnered with A depends on whether those responses represent real income changes or pure income shifting between partners. Figures 1 and 2 illustrate the former and

[11] If consumption enters a couple's utility function as total consumption, $c = c_A + c_B$, these two sets of indifference curves can be thought of as being the two-dimensional representations of (c, z) choices by each partner associated with a three-dimensional indifference map depicting (c, z_A, z_B).

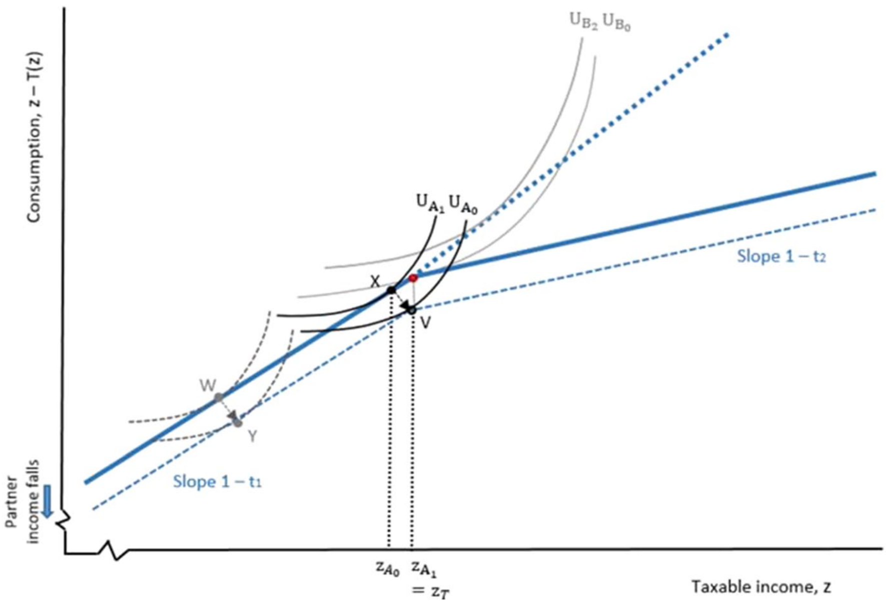

Fig. 2 Income-consumption choices: partner A

Fig. 3 illustrates the latter.[12] Two possible partnerships are depicted in Figs. 1 and 2. This shows, in the absence of the higher tax rate, t_2, the joint optimisation process leads to partner A earning taxable income below z_T, either at position W or X, with partner B again assumed to locate at K. That is, prior to any tax change each partner is assumed, based on their ability levels and earning/consumption preferences, to locate above and below the new tax threshold. When t_2 is introduced on B's income, the usual budget constraint pivot takes place such that B, as the marginal buncher, moves down to the kink at M with $z_B = z_T$ (B's final position is discussed below).

The income effect on partner A of a real reduction in B's taxable income implies a fall in A's unearned income and thus a downward shift in his or her budget constraint.[13] Figure 2 depicts this case. There is thus a negative unearned income effect on A causing the budget constraint to shift downwards. If partner A were previously

[12] Some indifference curves in Figs. 2 and 3 appear to intersect, but this is due to each set of curves representing different partners, or mutually exclusive possible locations for one partner. For couples, these indifference curves for each individual are associated with maximisation of a joint utility function.

[13] The income effects discussed here differ from those typically addressed in the ETI literature, where it is usually assumed that, for an individual, these are zero or small. In the context of partnered individuals, the income effect of a partner arises when the own-price response of one individual leads to a change in that individual's contribution to total family income. This potentially generates a related response by the partner who is not directly affected by the tax rate change. Also, the two income effects shown in Figs. 1 and 2 can be thought of, at least conceptually, as the outcome of convergence to two new equilibria at L and V, as each location shift by A and B generates a succession of income responses by, and hence budget constraint movements for, the other partner.

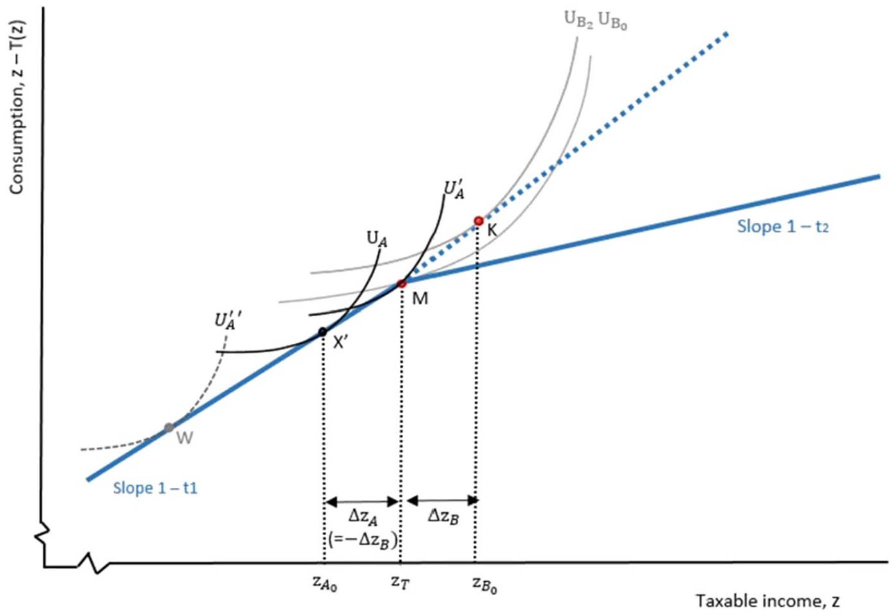

Fig. 3 Income shifting from partner B to A

located at *W*, *B*'s tax change induces a move by *A* to *Y*: *A*'s income rises but not enough to move to the kink. But if *A* were previously at *X*, there is a new equilibrium at *V*, and income rises sufficiently for *A* to move to the kink, thus 'bunching from below'. This, of course, also has an impact on *B* via an analogous positive income effect, so *B*'s budget constrain shifts upwards as shown, with a final position at *L*, not *M*.

Consider an analogous case where *B*'s reduction in taxable income, from *K* to *M*, is instead due to pure income shifting to partner *A* as an accounting devise to avoid the new higher tax rate. This case is illustrated in Fig. 3. Taxable income in this case represents income declared to the tax authority; similarly 'consumption' is after-tax income for each partner net of their respective tax declarations. Since the shifted income is taxable in the hands of the recipient, but there are no real income changes for the couple, there is no unearned-income shift in either *A*'s or *B*'s budget constraints in this case.

As Fig. 3 shows, with an unchanged budget constraint, partner *B*'s optimum involves moving to position *M* and shifting taxable income of Δz_B to *A*. How this affects bunching by *A* again depends on *A*'s initial position. Figure 3 illustrates a marginal bunching case where *A* is initially located at position X' with taxable income of z_{A_0} equal to $z_T + \Delta z_B$ (recall $\Delta z_B < 0$). Hence if *B* partners with *A* and shifts income of $|\Delta z_B|$, *A* also moves to position *M*, mimicking a taxpayer with indifference curves given by U'_A , rather than U_A. In this case both *A* and *B* bunch at *M*, respectively from below and above.

If joint optimisation before the tax change were to lead *B* to partner with *A* at a position to the left of X', such as *W*, shifting taxable income of $|\Delta z_B|$ to *A* would increase A's taxable income by $\Delta z_A = -\Delta z_B$, but insufficiently for A to bunch at z_T. Alternatively, if B partners with A at a position between X' and M, shifting $|\Delta z_B|$ to A would increase A's taxable income above z_T, such that some of this income becomes taxable at rate t_2. Equivalently B may shift only Δz_A ($< |\Delta z_B|$) to A such that the higher tax rate on the retained portion is instead paid by B. In such a case, either A or B, but not both, would be observed to bunch at M.

Finally, if B partners with an individual initially located in the vicinity (left or right) of X', income shifting from B to A is expected to lead to either or both partners imprecisely bunching in the vicinity of M. In all those cases, the income shifts result in A and/or B mimicking the behaviour of a taxpayer with different preferences (and hence different contributions to total household c and z) such as those shown by U'_A. Although individual contributions by A and B to total household c and z may vary across those income-shifting cases, total c and z (and hence joint utility) remain unchanged so long as the income shifting ensures no household taxable income is taxed at t_2, and income shifting is costless.

2.2 Tax minimisation by couples

Opportunities for income sharing across partners may also affect the location of the marginal buncher, facilitating more bunching by higher income individuals than equivalent singles. Consider, income shifting to minimise taxation in the case of a couple with incomes, in the absence of taxation, of y_A and y_B, where $y_B > y_A$. Suppose a two-rate income tax is introduced with tax rates τ_1 and τ_2 applying respectively above, and below, a tax threshold, z_T, such that $y_B > z_T > y_A$. There is an incentive for the couple to share taxable income, z, by some combination of changes in real income-earning and income-shifting responses, such that $z_B \leqslant z_T$. Their ability to achieve this by reallocating income within the couple is constrained by the size of the income gap, $z_T - y_A$.

In particular, if $y_B - z_T < z_T - y_A$, person B in the couple can shift taxable income to person A and locate exactly at $z_B = z_T$. Person A remains below z_T with taxable income of $y_A + y_B - z_T$. Alternatively, if $y_B - z_T > z_T - y_A$, the maximum reallocation, without person A shifting into the higher tax bracket, is $z_T - y_A$. Thus, person B has an incentive to move to $z_B = y_A + y_B - z_T$ instead of moving to z_T, while person A's income increases to the threshold at z_T. Hence the location of any excess mass associated with the response of person B is determined by the partner's income, y_A, in relation to the threshold. In each of these cases, the elasticity for person A is negative, while for person B it is positive.

The ability of a couple to shift income between themselves, up to the maximum of $y_B - z_T$, may be limited by frictions such as the nature of the tax law on income sharing, the extent of compliance enforcement, and the costs of coordinating taxable income-earning. However, for couples, the potential size of the income change associated with the location of the marginal buncher is likely to be greater than for single individuals, due to the additional option to reallocate income to a lower income partner, while also generating an additional reason to bunch above but close to z_T for person B in the couple, giving rise to imprecise bunching.

For example, consider the case where, in the absence of a tax kink, $y_A = 0$ and $y_B = 2z_T$. When a kink is introduced, income sharing would enable both individuals to bunch precisely at z_T; that is, the marginal buncher (from above) could have income, in the absence of a kink, equal to twice the tax threshold. While such a large income relative to the tax threshold is possible for single taxpayers, the required adjustment to reach z_T when a kink is imposed is more easily achieved where there is a non-earning partner with whom income can be shared.

It is also possible to observe partners in a couple where $z_i > z_T$, for $i = A, B$, who nevertheless benefit from the tax advantages of income shifting across partners. For example where $y_B > z_T > y_A$ such that, when the kink is introduced, there is a tax advantage to shifting $y_B - z_T$ to person A, legal constraints on the shifting process may mean that this is achievable only by shifting more than $y_B - z_T$ to person A. Thus, after a kink is introduced, both partners are in the same tax bracket facing the higher marginal rate, τ_1. Consider the example of a couple whose labour earnings alone would place them in different tax brackets, but who also earn rental income.

A common requirement is that rental income must either be shared equally among partners (if the rental property is owned jointly) or by one partner only (if that partner is assigned sole ownership). In order to reduce the couple's total tax liability, some rental income should be allocated to the otherwise lower-income person A (who would face τ_2 in the absence of any rental income). However, abiding by the tax code ensures that either $z_B > z_A$ or $z_A > z_B$ may be observed, with more rental income allocated to person A than is strictly necessary to minimise their joint tax liability.

Hence, with a joint tax minimisation objective, individuals in couples may seek to bunch, but are constrained in their ability to bunch precisely. They may be observed to bunch imprecisely, locating either in the same, or different, tax brackets, with taxable income movements involving both decreases and increases within the couple. Table 1 shows that, for the case of two individuals discussed above, where $y_B > z_T > y_A$, imprecise bunching by both members of the couple in the same tax bracket is either a sufficient, or a necessary and sufficient, condition to achieve joint tax minimisation, depending on the size of both incomes, y_i, with respect to the threshold, z_T.[14]

Table 1 shows that, as long as a couple's joint incomes are such that $y_A + y_B \leqslant 2z_T$, allocating individual taxable incomes, z_i, such that both individuals are located in the same tax bracket, is a necessary and sufficient condition for tax minimisation by the couple. If $y_A + y_B > 2z_T$, being in the same bracket is sufficient but not necessary. However, in this latter case there is an incentive for the individual with lower income, y_A, to shift taxable income towards $z_A = z_T$ from below. Increasing z_A further such that $z_A > z_T$ may also be tax-minimising but is not necessary; see "Appendix 1" for further discussion.

[14] As Creedy and Gemmell (2020) show, joint utility maximisation need not imply tax-minimisation. However, where income shifting within the family is the least costly means of adjusting to a higher tax rate, tax-minimisation provides a convenient approach to maximising post-tax incomes.

Table 1 Conditions for tax minimisation

Income range	Tax minimising condition	z_i: in same bracket?
$z_T < y_A + y_B < 2z_T$	$z_A < z_T; z_A \leqslant z_B$	Necessary and sufficient
$y_A + y_B = 2z_T$	$z_B = z_A = z_T$	Necessary and sufficient
$y_A + y_B > 2z_T$	$z_A \geqslant z_T; z_B \geqslant z_A$	Sufficient

Empirical analysis of bunching by couples who are in the same or different tax brackets cannot, of course, identify 'no tax' counterfactual income choices. Whether observed couples are in the same or different tax brackets is endogenous to the tax regime. Nevertheless, bunching that generates an excess mass in the income distribution at a kink is, by definition, a response to the tax imposition, even if it cannot be known whether any partners who are not observed to bunch, would have chosen a different tax bracket in the absence of the tax (or tax change). If, as demonstrated above, there is a potential tax gain for bunching individuals in a couple family to have a partner in the same, rather than different, tax bracket, *ceteris paribus* this might be expected to generate greater bunching by the former.

To the extent that there are constraints on income reallocation between partners (such as the legality, and monitoring, of income shifting, and different earning abilities) this limits the ability of couples to engage in sufficient income shifting to put them in the same tax bracket. If those constraints are weak, greater observed bunching by couples where both individuals are in the same bracket may be expected, and *vice versa* when these constraints become binding such that only limited amounts of income shifting are feasible.

3 The NZ income tax and administrative data

This section provides information about the New Zealand income tax structure in Sect. 3.1, with the construction of the matched dataset outlined in subsection 3.2.

3.1 The income tax structure

Following radical reforms in the 1990s, the New Zealand personal income tax system is a highly simplified version of many OECD income tax systems, with few deductions or allowances and no tax-free threshold. Individuals in couples are taxed separately. Taxable income includes wages and salaries, self-employment income (shareholder salary, partnership income, net business profits), dividends, interest and rental income. Pensions (including New Zealand Superannuation) and other transfer payments are taxable.

Table 2 shows tax rates and income thresholds before and after two major reforms in 2001 and 2011. Prior to 2001 there were just three tax brackets (2 kinks) with a top rate of 33 per cent. This changed to 4 brackets (3 kinks) with a top rate of 39

Table 2 Marginal tax rates and income thresholds (in NZ dollars)

Income range ($)	Marginal tax rate (%)	Income range ($)	Marginal tax rate (%)
2000 tax structure		2001 tax structure	
1–9500	15	1–9500	15
9501–38,000	21	9501–38,000	21
>38,000	33	38,001–60,000	33
		>60,000	39
2010 tax structure		2012 tax structure	
1–14,000	12.5	1–14,000	10.5
14,001–48,000	21	14,001–48,000	17.5
48,001–70,000	33	48,001–70,000	30
>70,000	38	>70,000	33

This table shows the income ranges and marginal tax rates applicable to personal incomes.

The four years shown are the first full tax years when the new rates shown applied. Major reforms occurred in 2001 and 2011, with a minor reform in 2010

per cent from 2001. This top rate was subsequently reduced again to 33 per cent in 2011, with minor rate and threshold changes in 2010. Those reforms have been used to examine taxpayer behaviour via taxable income elasticities by a number of previous papers including Thomas (2012), Claus et al. (2012), Carey et al. (2015), and Creedy et al. (2018).

Two features of the NZ tax system are the absence of almost all tax deductions (so that gross and net taxable income are closely aligned), and the relative ease with which income taxpayers can legally shift income between tax codes (personal, corporate and family trusts) and within tax codes between family members. Since tax rates applicable to income earned in trusts or companies did not change with the 2001 reform (their top rates remained at 33 per cent), the 2001 reform generated an incentive for higher-income earners to shift income out of the personal income tax code, especially via family trusts.

The 2011 reform, effective mid-way through the 2011 tax year, reduced all income tax rates and the company tax rate, raised the GST rate, and made numerous other small changes. The 2011 tax rates were therefore composite rates reflecting the two income tax structures during that year. Tax rates and thresholds remained unchanged thereafter. A feature of the 2011 reform was that the top personal income tax rate and the rate applied to income received through trusts became aligned again at 33 per cent, but the company income tax rate was cut to 28 per cent. Hence, there remained some tax advantages for income earned through companies and via within-couple personal income sharing.[15] The potential impact of the 2001 and 2011

[15] For 2009 and 2011, the close proximity and mid-year tax rate changes make the period 2009–2011 unreliable for bunching estimates. They are omitted from the analysis below.

reforms on tax sheltering and on bunching at income tax kinks have been examined by Gemmell (2020) and Alinaghi et al. (2021) respectively, and hence are not the focus of the present paper.

An extensive system of state pensions, social welfare payments and family tax credits sits alongside New Zealand's personal income tax system. In particular, the state pension (New Zealand Superannuation, NZS) and various welfare benefits with assorted abatement rates are set at levels around the first tax kink (at $14,000). This makes the first kink unsuitable for ETI analysis using the tax kink bunching approach. The abatement of some welfare benefits, and especially the family tax credit system payable to sole parents and couples with children, can also affect taxable incomes around the second kink at $48,000.[16] For these reasons, when analysing tax kink bunching responses by couples, Sects. 4 and 5 focus primarily on the third (top) tax kink at $70,000 which is generally unaffected by the family tax credit regime.

3.2 The matched dataset

The data used here covers the New Zealand income taxpaying population from 2000 to 2017, using tax register data extracted from Statistics New Zealand's Integrated Data Infrastructure (IDI) which contains several administrative datasets. The primary Inland Revenue (IR) database covers individual taxpayers, containing detailed tax return information such as wages and salaries, self-employment income, pensions and capital income. Socioeconomic variables including gender, age and educational qualifications were then added from other IDI datasets. Without joint taxation, IR income data are collected only for individuals, requiring an extensive exercise to match individuals within families; see "Appendix 2".

The annual analyses use each census (2001, 2006, 2013) to match individuals to families, with comprehensive matching for 2013 (the only census available within the IDI). For other years the nearest census is used. While this probably imparts some inaccuracy for those non-census years, the results below do not suggest values obtained for census years are systematically different from those obtained for non-census years.[17] There are over 8 million observations for the period 2001–2008, and 15 million for 2012–2017, representing a large fraction of the total NZ income taxpayers, which rose from around 3 million to 3.8 million over 2001–2017. The analyses reported below are restricted to individuals aged from 15 to 70.

Some descriptive statistics are shown in Table 3. These are based on 2013 data, where the availability of the 2013 census in the IDI yields the most accurate

[16] For example, in 2017 New Zealand's system of family tax credits, based on the number and age of children in the family, begin to abate above a family income of around $40,000, and are paid up to an income of $55,000 for one-child families and $70,000 for two-child families. This potentially affects marginal tax rates around the second tax kink, especially in one-earner families with children.

[17] See Alinaghi et al. (2020) for results from those robustness checks. These considered the effect of using different census years. For example, using 2001 census relationship status to re-estimate ETIs for couples in 2004 and 2005, (whereas previously the nearest census, 2006, was used) yields similar results.

taxpayer partnership matching with demographic information. Comparing all individuals in couples with single individuals it can be seen, firstly, that the former have substantially higher incomes on average, around $51,000 versus $32,000, partly reflecting the older age on average of partnered versus single individuals (45 versus 37 years). Males and females are equally represented in both groups while the share of the self-employed is very much larger among couples: 21 versus 8 per cent.

This partly reflects the opportunity for both partners in a couple to earn self-employment (business) income within a family business, an option not available to single taxpayers. Nevertheless, as is well-known, this ‘family business’ characteristic with limited third-party reporting available, provides such self-employed couples with enhanced tax responsiveness opportunities. Table 3 also confirms that partnered taxpayers are less likely to be under 40 years old than singles: 36 versus and 58 per cent; while the distribution of ‘highest educational qualification’ across the four categories (none, school, post-school and university degrees) are remarkably similar across the two groups.

When comparing taxpayers who are observed to bunch at the top tax kink with those who are not, an important consideration is the most appropriate definition of non-bunching comparator groups. Clearly non-bunching taxpayers in general are spread across the income distribution, while top kink bunchers by definition are located around $70,000. Comparisons in Table 3 therefore specify non-bunching comparison groups, partnered or single, as those with taxable incomes close to, and either side of, the bunching window ($67,500 to $72,500). Specifically non-bunching groups are defined as taxpayers in income bins within $5,000 above or below the bunching window (that is, $62,500 to $67,500 and $72,500 to $77,500).[18]

One characteristic difference between bunchers and non-bunchers stands out in Table 3. Bunching taxpayers, both partnered and single, are more likely to be self-employed, but especially if they are in a couple: 25 per cent of partnered individuals who bunch are self-employed and 16 per cent of single bunchers are self-employed. Bunchers have slightly higher educational qualifications on average though differences are small. Otherwise, bunching and non-bunching taxpayers appear to have similar characteristics.[19] Finally, in 2013, of the approximately 2.7 million individuals in the dataset, around 84,000 (3.1 per cent) are estimated to bunch at the top kink, of whom nearly two-thirds (around 53,000) are in couples.

[18] Results for *all* non-bunching taxpayers are available from the authors on request. In most respects, other than average taxable incomes, these alternative non-bunching definitions yield similar non-bunching taxpayer characteristics.

[19] Of course, taxpayers observed *ex post* not to bunch, but locate close to the bunching window, may nevertheless be similarly responding to the tax rate difference by reducing or increasing their taxable incomes, but where the adjustment is unsufficient to move them into the bunching window. It is therefore unsurprising if they demonstrate similar characteristics.

Table 3 Descriptive statistics: 2013

Year: 2013	Couple All	Single All	Couple Bunch	Single Bunch	Couple No-bunch	Single No-bunch
Ave taxable inc	50,943	31,887	69,765	69,704	69,072	68,672
Median taxable inc	42,578	20,797	69,947	69,806	66,422	66,125
St dev taxable inc	58,036	57,450	1,516	1,551	5,393	5,348
Average age	44.9	37.4	45.4	45.0	45.0	44.3
Shares (per cent)						
Female	50.1	49.7	39.9	46.2	38.3	45.3
Self-employed	21.4	8.0	25.0	16.1	17.5	11.8
Age						
< 40 years	35.7	57.5	32.3	35.6	34.1	37.6
40–60 years	50.2	31.9	58.0	52.3	56.3	51.0
> 60 years	14.1	10.7	9.8	12.1	9.6	11.4
Highest educational qualification						
No Qualification	11.5	11.1	6.8	6.1	7.1	6.2
School	36.5	38.4	30.7	28.9	30.9	29.6
Post-school	26.8	25.4	30.2	27.5	30.7	28.3
Univ degree	25.2	25.1	32.2	37.5	31.3	36.0
Tax brackets						
1st	15.6	30.8	n.a.	n.a.	n.a.	n.a.
2nd	41.4	48.6	n.a.	n.a.	n.a.	n.a.
3rd	21.2	11.9	55.8	56.5	56.0	59.5
4th	21.9	8.7	44.2	43.5	44.0	40.5
Total observations	1,198,995	1,515,216	53,244	30,606	85,164	51,543

Bunch (No-bunch) = individuals estimated to bunch at (not bunch, but close to) the top tax kink. Ave = average; St dev = standard deviation; inc = income; Univ = university.

Post-school qualifications include, for example, tertiary diplomas below degree level

4 ETI estimation: method and results

The estimation method is described briefly in Sect. 4.1. Section 4.2 reports the ETI results for all taxpayers, with self-employed decompositions examined separately in Sect. 4.3. Further details of estimates are provided in "Appendix 3".

4.1 Applying the bunching method

The foundation of the bunching approach is the result that the elasticity of taxable income is proportional to the excess mass of the income density function around the income threshold, or kink point. Numerous derivations are available, so only a brief description is given here: for formal analyses see Saez (2010), Chetty et al. (2011), and Kleven (2016). Suppose the marginal rate over a given taxable income range is τ, and a new higher rate of τ_1 is introduced at the income threshold of z_T, initially associated with a density of h_T. The proportion, b, of people moving to z_T is denoted by the excess mass, B, measured as a proportion of the initial density, h_T; that is, $b = B/h_T$. The ETI, η, is obtained using:

$$\eta = \frac{b}{z_T \log\left(\frac{1-\tau_1}{1-\tau}\right)} \quad (1)$$

Individuals for whom it is optimal to move to z_T cannot all be expected to locate precisely at the kink, given uncertainties, adjustment frictions and optimisation errors. Spikes in the distribution of taxable income are therefore expected to be spread over a range of incomes around each tax threshold. The choice of range or 'window' is in practice selected visually. Individuals are grouped into income classes of equal size, and the relative frequency in each class, along with the associated arithmetic mean taxable incomes, are calculated. Income values are transformed by subtracting the threshold income and dividing by the income-group width. Based on the resulting histogram, the window defining the base of the spike is chosen.

The counterfactual density function is obtained by fitting an n^{th}-order polynomial to the observations, using a dummy variable to distinguish the base of the spike. The counterfactual densities are obtained from the polynomial, by omitting the dummies, with an additional step to allow for the fact that the excess density in the spike has to come from the range of incomes to the right of the income threshold.[20] To achieve this last requirement, the predicted densities are adjusted such that the area contained by the counterfactual distribution is the same as that of the observed distribution. Finally, the excess density, b, is obtained as the difference between the counterfactual distribution and the actual distribution, over the chosen window. Following Saez (2010), Chetty et al. (2011) and most subsequent bunching studies, a fixed bunching window is selected in most of the exercises below, based on visual inspection of the actual and counterfactual income distributions; "Appendix 3" provides further details.[21]

However, following Bosch et al. (2020), who propose a statistical approach to identify a data-driven optimal bunching window, the results are re-run using the Bosch et al. methods.[22] Their method essentially fits a regression to the grouped income distribution data, first excluding only the income group (bin) containing the tax threshold. Confidence intervals from this regression are then used to identify observations in a potential bunching window that sit outside those intervals. Clearly

[20] For some individuals in couples who would otherwise be in a different bracket from their partner, this is not necessarily the case, as argued earlier. However, this should not substantially affect the counterfactual density over the specified window.

[21] Results are obtained using adaptations of the Stata code provided by Chetty et al. (2011) at http://www.rajchetty.com/papers-categorized/. Except for later robustness tests, a 7^{th}-order polynomial and a [− 5,+ 5], or [-$2,500, +$2,500], bunching window are used for all results. Figure 9 in "Appendix 3" provides an illustration.

[22] This procedure is used to minimise arbitrariness and potential biases. The Bayesian Information Criterion (BIC) is used to determine the optimal degree of the polynomial.

this does not necessarily produce symmetry of the bunching window. As they suggest (p. 955), their 'proposed method does not impose any restrictions on the (a) symmetry of the window as it is purely driven by the data at hand'. Their approach is used in Sect. 4.4 to test the robustness of ETI estimates to alternative bunching windows, and in Sect. 4.5 to assess whether such an approach supports the earlier *a priori* suggestion that couples may bunch less precisely at tax kinks than singles.

The unit of analysis for all the bunching and elasticity estimates below is the individual taxpayer. For partnered taxpayers the relevant samples are of individuals who are members of a couple family. Thus, for example, when a sub-sample of self-employed taxpayers is the focus, individuals are included in the couples sample if they are self-employed; their partner may, or may not, also be included in the sample depending on whether they are also self-employed.

4.2 ETIs for all taxpayers

Estimates of taxable income elasticities for all single individuals and individuals in couples are shown in Fig. 4, along with 95 per cent confidence intervals. For couples, results are also shown separately for taxpayers whose partner is observed in the same tax bracket, and in a different tax bracket, in the relevant year. Further couple decompositions are discussed in Sect. 5. Figure 4 reveals a tendency for the ETI to rise soon after the two major reforms and decline in subsequent years. The sources of these temporal patterns are not of primary interest here; they are also observed for individual taxpayers, and discussed in more detail, by Alinaghi et al. (2021) where it is argued that they arise both from initially lagged responses to the 2001 reform, such as the expansion in the registration of tax-favoured trusts during 2001–2003, and the likelihood that early post-reform years capture short-run responses before full adjustment to the new tax structures.

Considering differences across taxpayer types in annual or pooled-year periods, results strongly confirm the *a priori* suggestion of higher elasticities for coupled individuals compared to singles, and for couples with both partners in the same tax bracket. Also, following the introduction of the higher top tax rate in 2001, ETI estimates increased over the next two to three years, reaching 0.368 for couples, and 0.274 for singles, in 2004. This increase probably reflects the relative ease with which personal income could legally be recharacterised in New Zealand at this time, and the impact of the 2001 reform that is known to have led to a large diversion of income via an increase in incorporation by small firms and the self-employed, and increasing use of family trusts after 2001.[23] Companies and trusts were taxed at 33 per cent in this period, while the top personal rate was set at 39 per cent from 2001 to 2008.

4.3 ETIs for the self-employed

Numerous empirical results in the ETI literature have established that the self-employed tend to have higher responses and bunch more at tax kinks. The argument

[23] See Buckle (2010) and Gemmell (2020) for discussion.

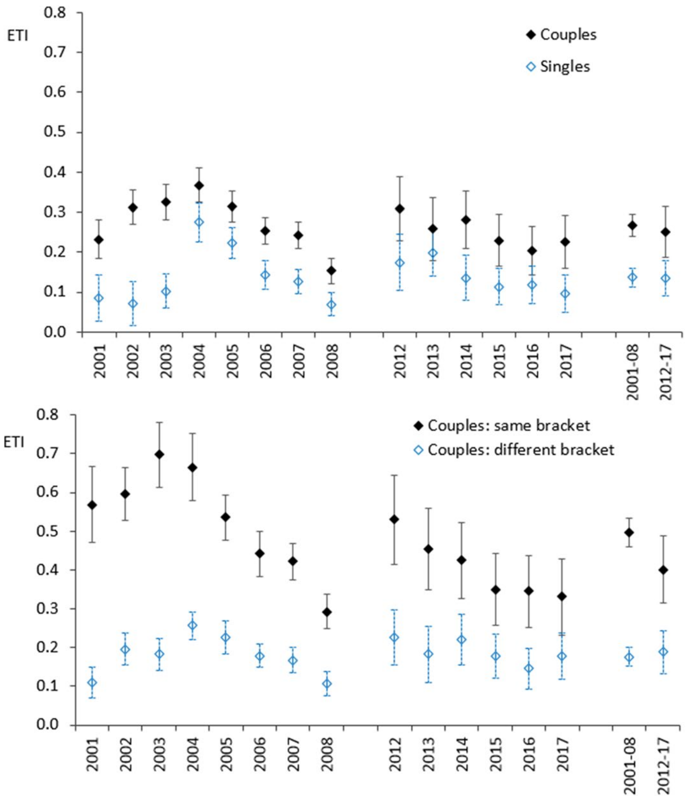

Fig. 4 Elasticities of taxable income by taxpayer type: 2001–2008 and 2012–2017

in this paper is that for couples in particular, there are greater opportunities to income share and determine joint taxable income levels where one or both partners are self-employed. Figure 5 shows annual and pooled ETI estimates over 2001–2017, including 95 per cent confidence intervals, for those taxpayers who are self-employed, defined as personal income taxpayers with non-zero business income.[24]

As expected, ETIs are substantially higher for the self-employed compared with all individuals in Fig. 4.[25] For example, pooled 2012–2017 values for single and partnered individuals are 0.801 and 1.083 respectively for the self-employed, but

[24] This includes taxpayers with negative business income. Self-employed taxpayers in a couple include only the self-employed individual: they may be partnered with an (excluded) wage-earner, or another (included) self-employed person.

[25] ETI estimates for wage-earners, not reported here, are small and not significantly different from zero, especially during 2001–2003 and from 2008 onwards. This is consistent with evidence elsewhere, suggesting third-party reporting, tax withholding by employers, and other constraints on employees' ability to misreport income, limit their behavioural responses; see, for example, Kleven et al. (2011), le Maire and Schjerning (2013), Kleven and Schultz (2014) and Kleven (2016).

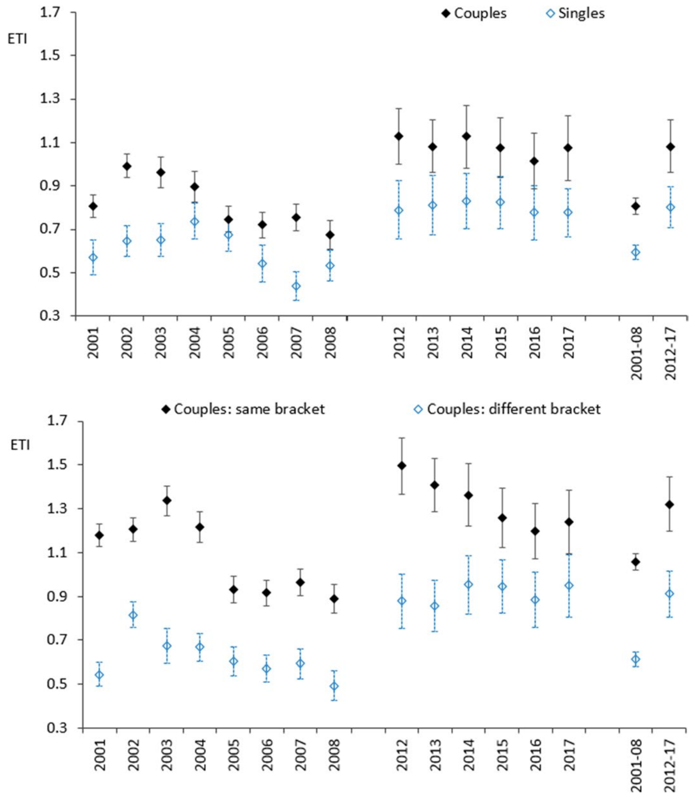

Fig. 5 Elasticities of taxable income: self-employed taxpayers 2001–2008 and 2012–2017

are 0.135 and 0.249 respectively for all individuals.[26] Throughout the two periods, 2001–2008 and 2012–2017, ETIs for self-employed individuals in couples are greater than for single individuals (and typically statistically greater). Similarly, in the lower panel of Fig. 5, for couples in the same tax bracket *ex post*, ETIs are greater than for couples observed in different tax brackets. In general, the ETI patterns observed over the two periods for both couple and single groups are similar to those found above for all taxpayers; for example, rising to peaks around 2003, followed by declines to 2008.

This is particularly the case for partnered individuals, where tax incentives to locate in different tax brackets were reduced from 6 to 3 percentage points after 2011. Nevertheless, by 2017 all ETI values generally remain above their 2008 equivalents, suggesting that if the limited reduction in bunching after 2011 arose from

[26] Results from *t*-tests for differences in excess mass estimates between singles and couples, and between couples in the same and different brackets in Appendix Table 13, confirm that all differences are statistically significant at 5% except for the single-couple excess mass difference in 2005.

inertia, or some form of friction, it persisted to at least 2017. Alinaghi et al. (2021) find evidence of such persistent adjustment costs while examining ETIs for individual taxpayers, but without any single/couple distinctions.

These results provide strong support for the two hypotheses that, first, ETIs are larger for individuals in couples compared with single individuals and, second, that elasticities are larger for couples where both partners are in the same income tax bracket. Furthermore, self-employed individuals in couple families, who can be expected to face fewer constraints on sharing income, reveal especially large elasticities.

Results for the self-employed are consistent with evidence from the broader tax compliance literature that has tended to find higher elasticities where there are higher incentives and opportunities to evade or avoid tax; see, for example, Slemrod (2007), Kleven et al. (2011). They are also compatible with the known income shifting opportunities within the New Zealand tax system, and where small, self-employment businesses form a large fraction of personal taxpayers; see, for example, Cabral et al. (2020), Gemmell (2020) and Alinaghi et al. (2021).

Thus, the relatively high ETI estimates are plausible here, especially for couples, given the known intra-couple income shifting mechanisms. These include the relative ease with which non-wage income can be allocated within a couple, and the high degree of discretion over wage levels and dividend allocations for partners working in small family businesses.

Further results reported in “Appendix 3” show that, for the self-employed, the 2001–2008 average ETI estimates for singles and partnered individuals in different brackets are close (0.594 and 0.613 respectively), but are less close on average during 2012–2017 (0.801 versus 0.912), albeit with relatively wide confidence intervals. These results suggest that the responsiveness of partnered taxpayers observed in different tax brackets is not much different from single taxpayers. This could arise for at least two reasons.

First, observing some couples in different tax brackets may indicate that they choose to earn quite different amounts for non-tax reasons and are genuinely unresponsive to the tax rate differences in labour supply terms (as with similar single taxpayers), but are also unwilling to engage in intra-family income shifting. Second, the observation that the two partners are in different tax brackets may indicate that adjustment costs, pecuniary and non-pecuniary, of income shifting are perceived as exceeding the expected tax gains. Thus, as argued above, the most responsive observed couples may be those who successfully minimise tax by earning taxable income in the same tax bracket, while those observed in different brackets are either unwilling or unable to do so. Without more finely-grained data, and without data on ‘no tax’ counterfactual incomes, it is not possible to distinguish between those two possibilities.

Nevertheless, two further couple decompositions can offer additional insights. First, self-employed taxpayers who are partnered with other self-employed taxpayers can be expected to have greater opportunities to share income (and hence display higher ETIs) compared with self-employed taxpayers who are partnered with a wage-earner. Second, among wage-earning individuals, around 11 per cent are known to be partnered with a self-employed taxpayer. Although the dataset

Table 4 ETI estimates for different partner decompositions

Taxpayer type	Taxpayer's partner type			SE-only
Self-employed (SE)	All	SE-only	WE-only	Share (%)
Pooled: 2001–2008[a]	0.807	0.926	0.483	69
	(35.4)	(35.1)	(22.3)	
Pooled: 2012–2017[a]	1.083	1.281	0.657	62
	(14.5)	(14.1)	(12.7)	
				SE-only
Wage-Earner (WE)	All	SE only	WE only	Share (%)
Pooled: 2001–2008[a]	0.069	0.114	0.061	11
	(4.2)	(4.7)	(3.8)	
Pooled: 2012–2017	0.063	0.081	0.055	11
	(1.9)	(1.8)	(1.7)	

[a] *t*-tests of SE-only and WE-only excess mass differences are significant at 5 per cent

does not identify how many of the latter are wage-earners employed in their partner's own business, this group is likely to contain a substantial fraction of such wage-earners. If so, the tax responsiveness of the sub-group of 'wage earners partnered with a self-employed taxpayer' could be expected to display a higher ETI on average than the ETI for two wage-earning partners.

Results from these two exercises are reported in Table 4, with *t*-ratios in parentheses below estimates. To save space here, this shows ETIs only for the pooled 2001–2008 and 2012–2017 samples, but results obtained for individual years are consistent with the pooled results, as shown in "Appendix 3". The top half of Table 4 reports ETIs for all self-employed taxpayers who are in a couple (All) and for the decomposition into those with self-employed partners (SE-only) and those with wage-earning partners (WE-only). The former represent 69 per cent of the 2001–2008 sample and 62 per cent of the 2012–2017 sample; that is, self-employed taxpayers in a couple have a tendency to partner with another self-employed taxpayer. The lower half of the table shows a similar decomposition for the group of all wage-earning taxpayers who are in a couple—those with a self-employed (SE-only), or wage-earning (WE-only), partner. Unsurprisingly, in this case wage-earners in a couple tend to be partnered with another wage-earner (89 per cent). Nevertheless, a substantial minority (11 per cent) of partnered wage-earners are in a couple with a self-employed person.[27]

Both hypotheses discussed above are supported by these results. First, among self-employed taxpayers in a couple, the ETI estimate is statistically significantly higher when that taxpayer is partnered with another self-employed person rather than a wage-earner: 0.926 versus 0.483 in 2001–2008 and 1.281 versus 0.657

[27] For example, for the pooled 2012–2017 results, of approximately 5.4 million observations for all wage-earners in couples, around 580,000 were partnered with self-employed taxpayers.

in 2012–2017. Second, when a wage-earning taxpayer is in a couple with a self-employed partner, the ETI estimate is larger (significantly for 2001–2008) compared to couples consisting of two wage-earners: 0.114 versus 0.061 in 2001–2008 and 0.081 versus 0.055 in 2012–2017. While this does not establish whether the result is driven by wage-earners employed by their self-employed partners, this seems a plausible contributor to the higher average ETI values estimated for this group.

4.4 Data-determined bunching windows

Bosch et al. (2020) have argued recently that the typical approach to identifying the bunching window—visual assessment of the excess mass of the actual income distribution relative to a high-order polynomial counterfactual distribution—can be improved upon by applying a more rigorous statistical approach. In this section, the analysis behind the results in Fig. 4 for the self-employed is repeated, but applying the Bosch et al. approach rather than adopting a fixed [-5, 5] bunching window and polynomial order.

Results were obtained using a flexible data-determined window alongside either a common polynomial (of order 7) across all specifications or a flexible data-driven polynomial order; see Bosch et al. (2020, pp. 955–957) for details. Both approaches yield very similar results. Those using the common polynomial order are reported in Table 5.[28] The left-hand columns of Table 5 suggest that the data-driven procedure leads to a choice of a narrower window in all cases, with windows at most [− 3, 3], and often narrower, rather than the fixed [− 5, 5].

The elasticity estimates in the right-hand columns show that this, unsurprisingly, leads to slightly lower ETIs in all cases. However, both the general pattern of ETI estimates over time, and the differences between ETIs for couples and singles, are similar to those obtained using the fixed bunching window. For example, the ETIs obtained using the flexible window are typically up to 0.2 lower than with a fixed window. However, the difference between ETIs for couples and singles using the fixed window averages about + 0.25 over 2001 to 2017 (couples higher), while the equivalent difference in ETIs using the flexible window approach averages + 0.24.

4.5 Imprecise bunching

Section 2 proposed that bunching in the vicinity of, rather than precisely at, the kink might be greater for partnered individuals than for singles due to the ability of the former potentially to shift large amounts of income between partners, and possible indivisibilities inherent in that intra-couple sharing process. This could be evident in a wider bunching window being observed for individuals in couples compared with singles. Previous estimates adopted as a default a common window across couples and singles to assist comparability. However, the data-determined, flexible

[28] The excluded region here is set from $x_- = -40$ to $x_+ = 40$. The confidence interval used for determining the bunching window is 95%.

Table 5 Comparing fixed and data-determined bunching windows

	Bunching window width			Taxable income elasticities			
Window	Fixed	Bosch et al.		Fixed	Bosch et al.	Fixed	Bosch et al.
Year	All	Couples	Singles	Couples	Couples	Singles	Singles
2001	[− 5,5]	[− 1,2]	[− 1,1]	0.806	0.632	0.570	0.441
2002	[− 5,5]	[− 3,2]	[− 1,2]	0.993	0.841	0.646	0.582
2003	[− 5,5]	[− 3,2]	[− 1,1]	0.963	0.846	0.651	0.507
2004	[− 5,5]	[− 2,3]	[− 2,2]	0.896	0.771	0.758	0.579
2005	[− 5,5]	[− 3,2]	[− 1,2]	0.747	0.656	0.658	0.460
2006	[− 5,5]	[− 3,2]	[− 1,2]	0.721	0.613	0.542	0.429
2007	[− 5,5]	[− 3,3]	[− 1,2]	0.756	0.694	0.438	0.390
2008	[− 5,5]	[− 2,3]	[− 2,2]	0.675	0.604	0.534	0.461
2001− 08	[− 5,5]	[− 3,3]	[− 1,2]	0.807	0.730	0.593	0.474
2012	[− 5,5]	[− 1,3]	[0,2]	1.127	0.948	0.771	0.554
2013	[− 5,5]	[− 1,2]	[− 1,2]	1.081	0.858	0.811	0.668
2014	[− 5,5]	[− 1,2]	[− 1,2]	1.126	0.906	0.832	0.675
2015	[− 5,5]	[− 2,2]	[− 1,2]	1.076	0.898	0.825	0.691
2016	[− 5,5]	[− 1,2]	[− 1,2]	1.015	0.838	0.777	0.606
2017	[− 5,5]	[− 1,2]	[− 1,2]	1.074	0.935	0.777	0.686
2012− 17	[− 5,5]	[− 1,2]	[− 1,2]	1.083	0.882	0.801	0.660

The Bosch et al. flexible window application uses a 95 per cent confidence interval and fixed polynomial order of 7. Varying the polynomial order yields similar ETI results

procedure examined in Sect. 4.4 suggested narrower windows may be appropriate in general. This subsection investigates whether there is empirical support for a wider window for partnered individuals compared with singles, using both the flexible and fixed window approaches.

First, using the flexible approach, this question can be addressed by comparing the couples and singles bunching windows in Table 5. This reveals that during the first post-reform period, 2001 to 2008, the data-determined window for couples is wider than for singles in all eight years (and for the pooled 2001-08 period). After the second reform in 2011, the couples window is wider only in two of the six years (2012, 2015), while for the other years both flexibly selected windows are the same. In no year is a larger window chosen for single taxpayers.

These results accord with the characteristics of the two tax regimes after the 2001 and 2011 reforms. For 2001 to 2008, there was a 6 percentage point difference between the two highest marginal tax rates, and the personal and family trust tax rates were similarly mis-aligned. However, after the top tax rate was reduced to 33 per cent in 2011, there was only a 3 percentage point difference in the two highest marginal rates and the personal and family trust tax rates were aligned, providing much less incentive to use family trusts for income shifting or sharing. It is perhaps unsurprising therefore that imprecise bunching by couples was especially reduced during 2012–2017 compared to 2001–2008.

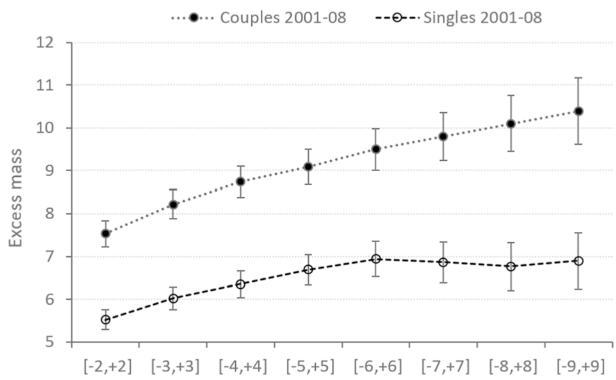

Fig. 6 Bunching windows for couples and singles

Second, the fixed window approach can also be used by increasing and decreasing the window around the benchmark of [− 5, 5]. As previously, this exercise is also conducted for the self-employed (who bunch more in general) and for the pooled 2001–2008 years when, as discussed above, bunching was most responsive to the top tax kink and the flexible window approach suggests greatest differences.

Figure 6 shows the excess masses, with 95 percent confidence intervals, for partnered and single individuals when the bunching window is increased from [− 2, 2] to [− 9, 9], where each ±1 represents ± $500. Though [− 2, 2] may be too narrow to capture all of the excess mass, especially for couples (the Bosch et al. method in Table 5 suggests [− 3, 3] for 2001—08), increasing the width of the bunching window might be expected to lead to greater excess mass for couples more than for singles. Figure 6 reveals that, using these fixed, symmetric windows, excess mass estimates increase for both groups as the window is increased from [− 2, 2] towards the benchmark [− 5, 5] case. However, when increasing the window above this benchmark, excess mass values for singles quickly become stable and remain well within relevant 95 per cent confidence intervals. By contrast, excess mass estimates for couples continue to increase as the window is widened to [− 9, 9] around the kink.[29] As with the flexible window test, these results point to the possibility that using a wider bunching window that allows for more imprecise bunching by partnered individuals compared to singles, captures tax kink responses more comprehensively.

5 Decomposing bunching taxpayers

This section explores some of the characteristics of bunching and non-bunching couples in more detail. Section 5.1 begins by decomposing couples into those where both partners bunch, only one partner bunches, and equivalent non-bunching

[29] Further widening of the bunching window is constrained by the presence of round number bunching at [− 10, + 10]; see Alinaghi et al. (2020) for discussion and testing of round number bunching.

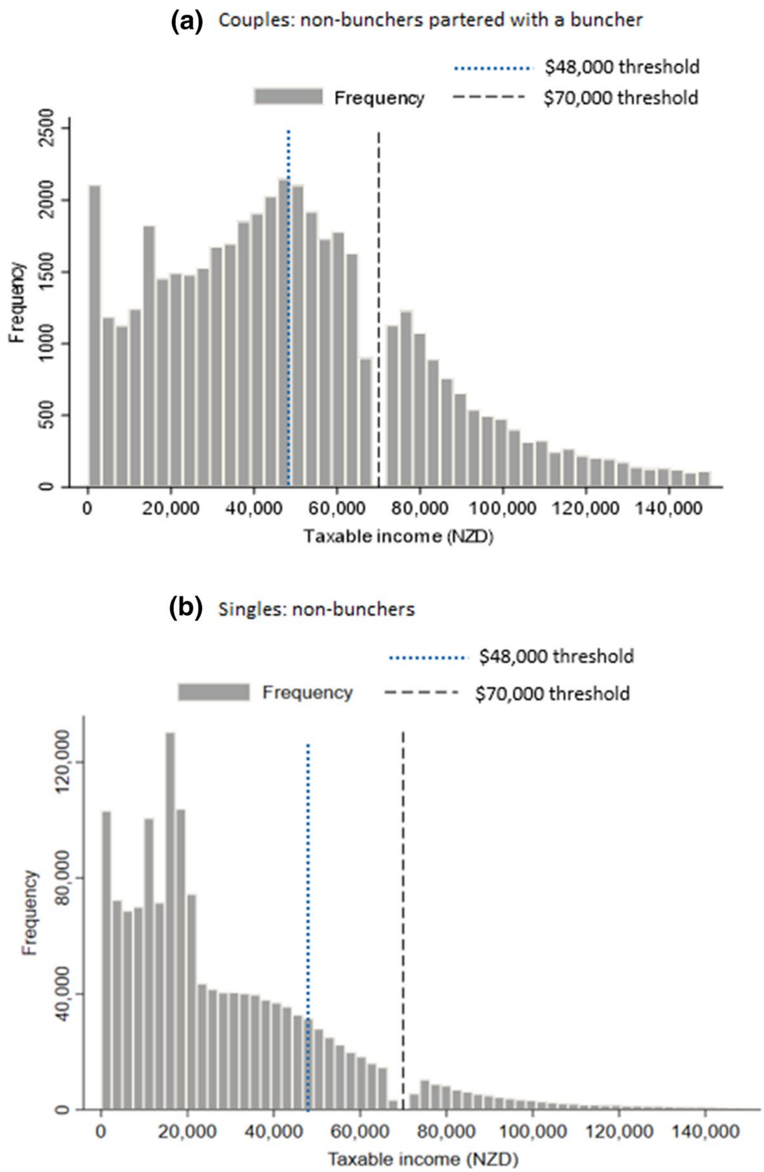

Fig. 7 Taxable income distributions: non-bunching partners versus singles

couples. Section 5.2 considers an alternative decomposition where the partner observed to bunch is the lower, or higher, taxable income earner within the couple, or where both partners declare equal taxable incomes. Section 5.3 then examines how ETIs differ across some of those decomposed groups. The data examined for these exercises relate to 2013, when the matching of partners within couples, and associated demographic data from the 2013 census, is most accurate. These decompositions provide further insight into the opportunities for taxable income shifting available to, or created by, partnered taxpayers.

5.1 Couple bunching characteristics

Taxpayers in couples who bunch at the top tax kink may be the higher or lower income earner of the couple: for around 70 per cent of couples with one top tax kink buncher, this is the higher earner of the two (see Table 7). Figure 7 shows the frequency distribution of all non-bunching individuals in a couple whose partner bunches (upper panel) and the equivalent distribution of non-bunching single individuals (lower panel). Both panels show the top two tax thresholds, at $48,000 and $70,000; in the case of the $70,000 threshold the 'missing observations' are due to the omission from the data shown here of the relevant top kink bunchers (within the couple, or single).

Two features stand out. First, a much larger fraction of non-bunching partners have income above the top tax kink (and are therefore the higher earner of the couple) compared to single non-bunchers: 26 per cent versus 8 per cent. Second, there is a clear mode in the non-bunching partners' income distribution around the $48,000 tax kink, but no similar pattern in the non-bunching singles distribution. Thus, although the analysis here has not attempted formally to measure excess mass around the $48,000 threshold, it is clear that (top kink) non-bunchers within couples have a strong tendency to bunch around $48,000, while singles do not. This provides further evidence that coupled taxpayers bunching at the top tax kink tend to cooperate with their lower-earning partners to locate at the lower kink.[30]

Section 5.2 examines the high-low earner aspect of couples further. Before doing so it is useful to consider the taxable income composition of the various bunching and non-bunching couple groups. Table 6 shows the main taxable income components for each bunching and non-bunching couple type (all bunchers in couples, both partners bunch, only one partner bunches; and similarly for non-bunchers).[31] These reveal some interesting differences across groups. For example, comparing couples who have at least one bunching partner, with both non-bunching individuals in a couple, the share of wages and salaries in total taxable income is somewhat higher for the latter (at 77 per cent versus 85 per cent respectively). However, there are more substantial differences between couples where both partners bunch versus one buncher only.

When both partners are observed to bunch, only 39 per cent of their total taxable income arises on average via wages and salaries, while this fraction is 82 per cent when only one partner bunches. It can be seen from the table that, instead of wage and salary income, when both partners bunch they are characterised on average by

[30] A similar frequency distribution for *all* non-bunching partners in a couple indicates a similar tendency for a mode around $48,000, suggesting that, even if the higher earner does not bunch at $70,000, the lower earner reveals some propensity to bunch at $48,000.

[31] To assist comparability of incomes across bunching and non-bunching groups, this table adopts the earlier, narrower definition of non-bunchers—those within $5,000 of the bunching window.

Table 6 Taxable income components of bunching and non-bunching couples

Type of	Bunch			No-bunch		
Taxable income	(All)	(Both)	(1-only)	(All)	(Both)	(1-only)
Shares (on average) of total taxable income						
Wage and salary	0.77	0.39	0.82	0.84	0.85	0.77
Partnership income	0.01	0.06	0.01	0.01	0.01	0.02
Shareholder salary	0.15	0.42	0.11	0.09	0.09	0.15
Net profit	0.02	0.01	0.02	0.02	0.02	0.01
Interest	0.01	0.02	0.01	0.00	0.00	0.01
Dividends	0.01	0.03	0.01	0.01	0.00	0.01
Estate/trust	0.01	0.03	0.00	0.00	0.00	0.01
Other	0.02	0.02	0.02	0.02	0.02	0.02
Total observations	52,272	6,132	46,140	83,871	79,356	4,515

This table shows the shares of 2013 taxable income components by couple type. Columns 1–3 refer to couples who bunch (all in col. 1; both partners bunch in col. 2; only 1 partner bunches in col. 3). Similarly for non-bunchers in columns 4–6. Non-bunchers in col. 4 are partnered with a buncher in col. 3. Total observations in each category (col.) exclude individuals where data are missing for some income types

higher shares of partnership income and, especially, shareholder salaries. They also have higher shares of dividend income and trust income. These income types are particularly associated with the self-employed and are also relatively flexible in their allocation (legally) between partners for tax purposes.

Net profit (or business income) is typically a relatively small percentage (1 to 2 per cent) on average, and similar for bunchers and non-bunchers in couples. This may seem surprising, until it is recognised that income tax liability can be reduced when net profit is negative (reducing the average net profit share here), which can then be off-set against other, positive taxable income types. Thus, a zero or negative net profit (a business loss) for one partner can be used to help either or both partners bunch at the tax kink, and potentially reduces taxable incomes of non-bunching taxpayers. Finally, Table 6 shows that the use of estates/trusts as a vehicle to earn taxable income results in less than half a percent income share for most groups, but is 3 per cent for couples where both bunch.[32] This supports the earlier suggestion that couples may make greater use of trusts to earn taxable income since this vehicle facilitates income sharing.

5.2 High and low income partners

For couples with two unequal incomes, either partner may bunch at the top tax kink, while couples with equal incomes are also possible. As the data in Table 7 reveal,

[32] Income tax rules applied to trusts, such as family trusts, also apply to the estates of people who have died, where that estate continues to earn income after death.

Table 7 Descriptive statistics by partner income levels

Partner type	Lower income	Higher income	Equal income
Ave taxable income	32,624	72,046	22,745
Median taxable income	28,232	60,109	15,119
St dev taxable income	30,888	71,626	35,594
Bunchers (number)	14,505	37,365	1,377
Percentage of all bunchers	27.2	70.2	2.6
Average age	44.0	44.8	55.8
Bunchers	45.8	45.2	47.9
Non-bunchers	45.2	44.9	48.3
Female (per cent)	70.0	30.2	50.1
Bunchers	66.4	29.3	50.2
Non-bunchers	64.7	28.8	50.0
Self-employed (per cent)	22.0	19.8	32.3
Bunchers	33.0	19.9	80.0
Non-bunchers	22.2	15.1	70.5
Total observations	571,305	571,305	56,388

Ave = average; St dev = standard deviation

equal partner incomes are observed with both bunching and non-bunching individuals. In the latter case this is typically associated with state pension recipients who both receive the universal NZ Superannuation payment and have no other taxable income. For present purposes, however, of particular interest are partners with equal and unequal taxable incomes who bunch at the top tax kink.

Using the earlier definition of non-bunching individuals (those within $5,000 of the bunching window) to assist comparability, Table 7 shows that around 70 per cent of bunchers are the higher earning partner, and 27 per cent are lower earning partners with the remaining 3 per cent having equal incomes.[33] Lower earners are predominantly female (70 per cent) and this is the case for both bunchers and non-bunchers. The major difference between the three income groups is the association with self-employment. While the shares of self-employment among both higher and lower income partners who do not bunch are around 15 and 22 per cent respectively, for bunchers a much higher fraction of lower earning bunchers are self-employed, at 33 per cent. More dramatically, 80 per cent of bunchers declaring equal incomes are self-employed. Even for the (narrowly defined) non-bunchers who are close to the bunching window, 70 per cent are self-employed. These latter results suggests strongly that self-employed couples are most able to ensure that they declare taxable incomes at, or close to, the tax kink. These distinctions also turn out to be important for differences in taxable income elasticities across groups as discussed in Sect. 5.3.

[33] Considering couples with unequal incomes and where only one partner bunches at the top kink, perhaps unsurprisingly, a substantial majority (75 per cent) of the non-bunching partners have lower income than their bunching partner, and 25 per cent of non-bunching partners having income above their bunching partner's income.

Finally, the earlier analysis suggested that income sharing between high and low income partners in a couple would tend to raise the income of the lower earner towards the kink and vice versa for the higher earner. While this might be expected from any or all taxpaying couples where one partner is above, and one below, the top tax kink, it might be expected to be especially evident among couples where the higher income partner is observed to bunch at that kink compared to higher earning partners who do not bunch. That is, bunching by the higher earner may reflect a stronger tendency and greater ability for intra-couple income sharing. Again examining data for 2013 shows that, for couples where the higher earner bunches at the top kink, taxable incomes for the lower earner average $35,110 (or $34,890 below the top kink) while the equivalent average income where the higher earner does not bunch is $26,485 (or $43,515 below the top kink). This is at least suggestive of the possibility that bunching (from above) by higher earners in a couple is at least partly facilitated by sharing income with their lower income partner.

5.3 ETIs for different bunching groups

Given the differences in some characteristics, mentioned above, between various sub-sets of single and partnered individuals, it is interesting to consider whether and how these differences are associated with heterogeneity in taxable income responses.[34] For example, given established differences between males and females in labour supply and avoidance responses to taxation in the existing literature, are these differences mirrored in the partnered and single groups examined here? Do older or younger singles or partners display higher ETIs?[35] Are bunching responses greater within couples where the lower or higher earner bunches?

Table 8 reports ETI results for sample decompositions based on gender, age, highest educational qualification and whether the buncher is the lower, higher or equal income partner within the couple. Like the earlier decompositions discussed in Sect. 3.2, these results are based on the most robust 2013 census year data. Results for these decompositions may be compared with the original 2013 ETI results reported in Fig. 4 for couples (0.258) and singles (0.198).

First, results for all decompositions yield larger ETI point estimates for individual taxpayers in couples than for singles, though these are not always statistically significant.[36] Second, as some bunching and labour supply studies have found (see, for example, Paetzold 2019; Bergolo et al. 2021), within couples ETIs for females

[34] A number of further robustness checks are reported in a working paper version of this article: Alinaghi et al. (2020). These include testing whether ETIs, and differences across single and couple groups, are sensitive to (i) the use of census relationship data for years when same-year census information is not available; (ii) the size of the bunching window, bin width and polynomial order; (iii) bunching at (income) round numbers.

[35] In their analysis of labour income in Uruguay, for example, Bergolo et al. (2021) distinguish between workers below, and above, 40 years old, within an 'active labour market' sample aged 21-60 years. See Bergolo et al. (2021; online appendix E).

[36] As Fig. 4 shows, the original results for 2013 reveal among the closest of the couple-single ETIs compared to estimates for other years.

Table 8 ETI estimates for taxpayer decompositions

Group	Couples		Singles	
	ETI	(95% CI)	ETI	(95% CI)
All	0.258	(0.179, 0.337)	0.198	(0.139, 0.257)
Gender				
Male	0.214	(0.165, 0.263)	0.195	(0.133, 0.256)
Female	0.328	(0.244, 0.411)	0.203	(0.132, 0.274)
Age (years)				
<40	0.172	(0.094, 0.250)	0.148	(0.083, 0.214)
40-60	0.293	(0.203, 0.383)	0.218	(0.150, 0.286)
>60	0.350	(0.254, 0.446)	0.258	(0.177, 0.340)
Highest educational qualification				
No qual.	0.265	(0.149, 0.381)	0.234	(0.083, 0.386)
School	0.281	(0.180, 0.382)	0.196	(0.108, 0.285)
Post-school	0.230	(0.157, 0.303)	0.147	(0.082, 0.212)
Univ. degree	0.256	(0.167, 0.344)	0.179	(0.099, 0.260)
Partner incomes				
Lower	0.431	(0.310, 0.552)	–	
Higher	0.157	(0.094, 0.219)	–	
Equal	3.253	(1.853, 4.654)	–	

95% CI = 95 per cent confidence interval based on excess mass standard errors. ETI estimates are based on 2013 data

appear to be higher than for males, whereas male-female ETIs are very similar for singles. This may indicate a greater tendency to adjust income via bunching by using secondary (typically female) earner incomes to a greater extent.[37] Indeed, results in the table for the lower and higher earners in a couple confirm a larger ETI when the top kink buncher is the lower earner of the two. Evidence here of similar ETI values for single male and female taxpayers may reflect a similar tendency for both genders to engage in tax avoidance activity—the tax response that tends to be more relevant than labour supply responses at higher income tax kinks.

The table also reports especially high ETIs for bunchers with equal incomes of both partners. As noted earlier, 80 per cent of those taxpayers are self-employed with a high degree of discretion in their intra-couple income allocation, suggesting that this ETI result may be capturing an especially tax-responsive sub-sample.[38] Finally, there is some evidence of higher ETIs by older taxpayers, both couples and singles. For example, ETI estimates for coupled individuals over 60 are twice as large as those for the under 40s. With the over 60s including a large proportion of

[37] Bergolo et al. (2021) similarly find higher ETIs for females, suggesting, in their Uruguayan case, that this partly reflects behaviour associated with tax deductions. In the New Zealand case, this aspect is less likely to be important given the limited deductions available to personal income taxpayers. For self-employed couples, however, various income sharing and tax code switching options are available.

[38] However, some caution is warranted interpreting this result, since non-bunchers with equal partner incomes are a small and quite specific sub-sample.

retirees, this may partly reflect the greater ease with which unearned income can be adjusted to locate around tax kinks, especially for couples via income sharing. Finally, there do not appear to be any substantial differences in ETIs by educational qualification.

6 Conclusions

Recent papers hypothesise that elasticity of taxable income estimates for individuals may be underestimated where individuals are taxed separately, but some taxpayers are part of a couple. This was investigated here using the ‘bunching at tax kinks’ approach to obtain separate elasticities for partnered and single individuals around the top marginal tax rate. There are opportunities for, and constraints on, bunching that are specific to individuals in couples. To test these hypotheses, administrative records for New Zealand income taxpayers were matched to their partners using population census data. Excess mass and elasticity estimates were then obtained for various decompositions of single and coupled taxpayers.

The results provide strong evidence that ETIs are larger for partnered taxpayers compared with single individuals. It was also suggested that where constraints on income sharing among partners are relatively weak, larger elasticities can be expected for couples where both partners are observed in the same income tax bracket. The evidence strongly supports this argument and is consistent with known characteristics of the New Zealand income tax system where constraints on intra-family income sharing are relatively weak. Self-employed individuals in couples, who generally face fewer constraints on sharing income compared with partnered employees, reveal especially large elasticities.

When considering all taxpayers combined, ETI estimates are within the range of values commonly found for other countries, of around 0.1 to 0.4. Estimates here for self-employed individuals suggest high elasticities at around 0.80 and 1.08 for single and coupled individuals respectively. Furthermore, as hypothesised, these are high for self-employed individuals where partners are observed to earn income in the same tax bracket, with a point estimate as high as 1.32 for 2012–2017. Nevertheless, estimates for couples where partners earn income in different tax brackets are only slightly higher than similar single individuals (0.912 compared with 0.801 in 2012–2017).

Results also provided strong support for the hypothesis that, where there are two self-employed partners, the ETI is larger than when a self-employed taxpayer is partnered with a wage-earner. In addition, for the sample of wage-earners who are part of a couple, if the wage-earning taxpayer is partnered with a self-employed individual, the elasticity for such wage-earners is also larger. Although data are not available on the extent of family wage-earners within a self-employed business, this result may arise in part from a tendency for self-employed taxpayers in couples to employ their partner as a wage-earner, giving them discretion over the choice of wage and hence tax responsiveness.

These results for the self-employed are consistent with, and augment, previous evidence from the broader tax compliance literature that has tended to find higher elasticities where there are both higher incentives and opportunities to evade or avoid tax. The relatively high estimated values for the self-employed reported here are plausible, especially for couples given the known income sharing mechanisms available to them. In addition, decomposing samples of bunching couples by gender, age and the size of each partner's income, again suggested especially strong responses associated with being the female, and/or secondary earning, partner. Older couple age groups (over 60 years) also displayed higher ETIs perhaps due to greater opportunities for retirees to share unearned income.

These, sometimes large, differences in estimated ETI values for singles and couples suggest that tax authorities and policy advisers in a given country setting need to understand the mechanisms, opportunities for, and constraints on, taxpayers' behavioural responses to tax kinks arising from family structures. In particular, it is important to consider the extent to which incomes of family members are jointly determined, the ease of shifting taxable income within the family, and how far tax responsiveness may differ for partnerships involving one versus two self-employed taxpayers. Tax policy involves tax parameter and tax administration settings, including the size and allocation of compliance enforcement resources.[39] Results here highlight that the design of such administrative rules around income sharing within couples and among self-employed partners is one aspect that can substantially affect tax-kink bunching for given tax rate settings.

Appendix 1: Bunching and tax minimisation by individuals in couples

This Appendix provides analysis and illustrations of bunching by couples, discussed in Sect. 2. Section 2 considered a number of bunching cases arising from tax-minimisation strategies within couples in the same or different tax brackets. These are illustrated in Fig. 8, in which there is a single threshold or tax kink at $z_T = \$70,000$, with marginal tax rates of 0.2 and 0.4 below and above the kink respectively. A combined income range, $y_A + y_B$, from \$100,000 to \$200,000, is shown.

Each profile in the figure represents a fixed combined income, with taxable income of the lower earner, *A*, shown on the horizontal axis and total tax paid by the couple on the vertical axis. Labels 'S' and 'D' indicate whether the two individuals are in the same (S), or different (D), tax brackets; label 'K' indicates the kink at \$70,000. Unlabeled points in the figure to the left or right involve incomes located in different tax brackets.

Figure 8 shows that only precise bunching at the kink by both partners is tax-minimising when combined income is $2z_T = \$140,000$ (labelled 'K,K'). For combined incomes less than \$140, 000, tax minimisation requires both members of the couple to be in the same, lower taxable income bracket. Thus taxpayers who are observed to bunch imprecisely have an incentive to do so via locating in the same bracket. If combined income exceeds \$140,000, tax minimisation, achieved by imprecise bunching around \$70,000, involves locating in the same, higher tax bracket.

[39] See Keen and Slemrod (2017) and Creedy (2019).

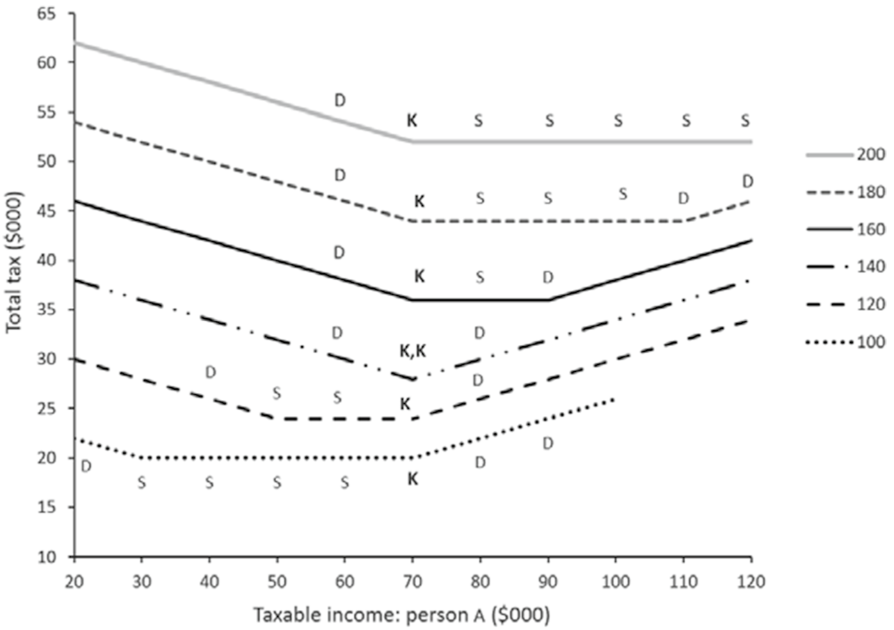

Fig. 8 Tax-minimising taxable income allocation by couples

These arguments suggest that, in addition to incentives for couples to bunch at the tax kink by suitable allocation of taxable income within the family, individuals in couples who attempt to bunch, but cannot bunch precisely at z_T, are most likely to bunch close to z_T within the same tax bracket to the extent that, for a given joint income, they are able to reallocate their taxable incomes. As a result, a tax-minimising strategy is consistent with observing imprecise bunching by one or more partners either below or above the kink.

Appendix 2: The New Zealand couples dataset

The database used for this study is the Integrated Data Infrastructure (IDI), maintained by Statistics New Zealand (SNZ). The IDI is a collection of national and regional data sources systematically and securely linked. It contains a wide range of administrative data sources from government agencies, the 2013 Census, SNZ surveys, and non-government organizations linked at the individual level. These datasets are linked through a spine which aims to include all people who have ever been a resident in New Zealand.[40] The IDI spine is constructed by linking tax records

[40] This includes individuals who were born in New Zealand, permanent residents, people with a visa which allows them to reside, work or study in New Zealand, and those who can live and work in New Zealand without requiring a formal visa.

(from 1999 onwards), New Zealand birth records (from 1920), and long-term visas (from 1997) probabilistically. Datasets within the IDI are deterministically linked where common unique identifiers are available. Otherwise, personal variables such as full name, date of birth, and address are used for probabilistic matching; see Statistics New Zealand (2014) for further details.

To examine the ETI for individuals who are part of a couple, relationship information is required. However, income tax liabilities in New Zealand are individually based and therefore, household and family-level variables are not collected for tax purposes.[41] On the other hand, all main benefits are income-tested at the family level, for which family relationship information is required and collected.[42] While this can be useful, the proportion of the working-age population receiving main benefits is about 9 to 10 per cent, and is obviously not representative of the overall national population. The IDI also includes several linked survey data sources such as the Household Labour Force Survey (HLFS) and the Survey of Families, Income, and Employment (SoFIE).[43] These datasets can be used to construct longitudinal family and household level variables but cover small samples of the New Zealand population over relatively short time periods.

Some information on the relationships between individuals within households can be found in the administrative data sources including New Zealand registrations of births, marriages, and civil unions from the Department of Internal Affairs; benefits information from the Ministry of Social Development; tax credit information from Working for Families; visa information from the Ministry of Business, Innovation and Employment; and Summary tables compiled from various administrative sources. However, these data sources provide either formal relationships or at best a fraction of informal relationships.[44] According to a NZ government report, about one in five New Zealanders who are living in a relationship have chosen not to marry: 336,591 people identified themselves as having a partner but not legally married in Census 2001.[45]

41 Some survey and administrative data in New Zealand, such as the 5-yearly census or annual Household Economic Survey, distinguish between families and households. The former involve familial relationships, such as parents and children, living in the same private dwelling; the latter involve independent individuals living at the same address, such as students or single professionals sharing accommodation. Thus a household may contain more than one family.

42 The main benefits in New Zealand include, but not limited to, Jobseeker Support (JS), Sole Parent Support (SPS), and Supported Living Payment (SLP). New Zealand Superannuation is the only benefit that is neither income-tested, nor asset tested. However, if a superannuitant chooses to include a partner aged under 65 in the payment, incomes of both partners are tested.

43 The Household Economic Survey (HES) also includes family/household level information but it is cross-sectional.

44 Formal relationships include legally registered marriages or civil unions; informal relationships consist of *de facto* partnerships and cohabitation.

45 For the full report see: https://www.beehive.govt.nz/release/questions-and-answers-civil-union-and-relationships-statutory-references-bills.

The national population censuses contain a wealth of demographic information about individuals and their families.[46] However, the only full census linked to the IDI (at the time of data collection) is 2013. This means that any change in household or family composition cannot be traced over time. Since income data in the IDI is available from 1999, the only two censuses which can be used to add more information on individuals' relationships prior to 2013 are 2001 and 2006, none of which is linked to the IDI. In order to link them to the IDI, linking variables are used. These datasets are anonymised, and therefore the main linking variables are date of birth (including year and month of birth), gender, and usual residence (meshblock code).[47] The main problem in linking these two stand-alone datasets to the IDI is that instead of date of birth, an age variable is reported. This makes the linking process difficult, if not impossible. To address this difficulty, two shortened versions of these datasets, including the date of birth, were subsequently provided by Statistics NZ.[48] The dates of birth are then derived from these shortened versions and added to the existing stand-alone censuses.

The number of individuals in censuses 2001 and 2006, after dropping duplicate records, are 3,769,257 and 4,083,147, respectively. The records with missing values for the main linking variables also needed to be excluded from these datasets. This includes records with missing dates of birth (year and month of birth) and records without residential information. Therefore, the number of records for the censuses 2001 and 2006 decrease to 3,547,311 and 3,916,803, accordingly. The final step before linking is to check whether these records are unique with respect to the linking variables. After the completion of this step, the numbers of records are slightly decreased, 3,230,085 and 3,525,789 for the 2001 and 2006 censuses, respectively.

Information about where people live is collected by various government agencies. As a result, address information in the IDI can be found in several data sources, including Ministry of Health (PHO and NHI registers), Ministry of Social Development, Ministry of Education, ACC (Accident Compensation Corporation), and Inland Revenue, among others.[49] The data recorded in the address table include a range of geographical information such as meshblock, area units, territorial authorities (TA), District Health Board areas (DHBs), and regions. It is possible that an individual appears several times in the address table if the residential address is recorded differently on different sources or a change of address is notified.[50] To be able to compare the area classification over time, a meshblock concordance table

46 In New Zealand, censuses are usually held every five years but the census scheduled for March 2011 was postponed for two years due to the Christchurch earthquakes in 2010 and 2011.

47 Meshblocks are the smallest geographical areas in NZ standard geographical classification, representing roughly 30 to 60 dwellings and/or 60 to 120 residents.

48 Statistics NZ agreed to provide a shortened version of censuses including the date of birth (to protect privacy, day in the date of birth is dropped and not reported) along with 17 other requested variables such as sex, ethnicity, family role, legal and social marital status, qualification, income and occupation, among others.

49 PHO and NHI refer to Primary Health Organisation and National Health Index, accordingly.

50 For the 2001 Census, the residential addresses with notification date prior to 1st January 2006 are collected. The date corresponding to 2006 Census is 1st January 2007.

Table 9 Summary statistics for the New Zealand taxpayer population

Taxpayer type:	2001–2008			2012–2017		
	All	Partnered	Single	All	Partnered	Single
Average taxable income ($)	31,846	39,317	24,955	45,584	55,555	36,954
Average age	41.8	46.7	37.3	42.2	46.0	38.9
Percentage of females	52.0	50.1	53.8	50.0	50.1	49.9
Total observations[a] (millions)	8.348	4.006	4.343	15.027	6.971	8.055

[a]Totals may not add exactly due to Statistics NZ confidentiality rounding rules

is used for mapping. Finally, personal details such as date of birth and gender are added to the residential address.

The census data derived from the earlier steps are then linked to the administrative data (IDI spine) using the linking variables. However, it is possible that one census record is linked to more than one IDI record due to the similarity in linking variables such as sex, date of birth and address.[51] These records are therefore excluded from the final datasets and the number of linked individuals for census 2001 and 2006 become 1,920,474 and 2,296,980.

The next step is to identify couples with both spouses linked to the administrative data. To be able to compare the elasticity of taxable income for this group of individuals with their single counterparts, the identification of both groups are required. To do so, a variable containing information on the role within the family group is used. These roles (and codes) are as follows: Not in a Family Group (00); Parent or Partner/Spouse (01); Child (02); Grandparent in Parent Role (03); Other Person in Parent Role (11); Child not with Real Parent (12); Unable to Code (50). There are 305,688 couples (611,376 individuals) and 1,044,969 singles, based on the 2001 Census, who are successfully linked to the administrative data. According to the 2006 Census, the number of couples is 384,330 (786,660 individuals) and 1,259,556 singles in 2006.

Table 9 presents some summary statistics for the two pooled samples (2001–2008 and 2012–2017) of all individuals, and partnered and single individuals. Average taxable income is generally substantially higher for individuals with partners compared to single individuals. For example, in 2012–2017, partnered individuals report around 50 per cent higher taxable incomes than singles. They are also around 6 to 7 years older on average than singles, and both groups are almost equally divided between males and females.

Appendix 3: Further details of excess mass and ETIs

This Appendix provides details of annual and pooled estimates of the extent of bunching by various taxpayer groups over the 2001 to 2017 period, for which it is possible to match individual taxpayers within the same family. Excess mass

[51] The inclusion of the name and day in the date of birth could improve the linking substantially but these are not provided due to the confidentiality concerns.

estimates are reported, along with ETI values used to produce the diagrammatic presentations.

Appendix 3.1: 2013 excess mass estimates

The excess mass values, used in obtaining ETI estimates, display somewhat different patterns between the two periods, 2001–2008 and 2012–2017. An illustration of the extent of bunching across different groups is shown in Fig. 9 for 2013, the most recent year where census family relationship data yield an exact match with taxpayer data for the same year. The top part of the figure shows bunching by all single individuals and those in couples; the lower part shows bunching by self-employed equivalents. Two features stand out: there is relatively larger bunching by individuals in couples compared with singles, and larger bunching by the self-employed compared to all taxpayers combined. A third feature is evidence of some round-number bunching, as discussed by Kleven and Waseem (2013). That is, there is some evidence of small positive excess mass at ±10 (±$5,000) intervals around the $70,000 top kink.[52]

Appendix 3.2: Pooled excess mass estimates

The excess mass values, used in obtaining ETI estimates, display somewhat different patterns between the two periods, 2001–2008 and 2012–2017. Figure 10 summarises excess mass estimates for singles and couples for the two periods, 2001–2008 and 2012–2017. The diagram plots average b values for all singles/couples, for the tax bracket-based couple decompositions, and equivalent values for the self-employed sub-samples. In each case, 95 per cent confidence intervals, based on bootstrap standard errors, are also shown. Unsurprisingly, given the large sample sizes involved, confidence intervals are generally small.

Recall that the values of b on the vertical axis represent the area (mass) of the observed distribution (in excess of the counterfactual distribution in the relevant window), as a ratio of the average mass of the counterfactual distribution within the window (±$2,500) around the kink. For example, for all single individuals in 2001–2008 and 2012–2017, Fig. 10 and Appendix Table 10 indicate values of b of 1.530 and 0.827; both are significantly different from zero. That is, excess mass is around 153 per cent and 83 per cent in the two periods respectively of the average counterfactual density around the kink.

Several bunching features are apparent in Fig. 10. First, b is significantly higher for coupled individuals compared to singles, and also for coupled individuals in the same tax bracket compared to those in different tax brackets.[53] Second,

[52] With $500 income groups used here, the round-number bunching observed at $5,000 intervals (multiples of 10 on the horizontal axis) include reported taxable incomes within a ±$250 range, such as from $79,750 to $80,250.

[53] Since these excess mass estimates relate to the top tax kink, coupled individuals in the same tax bracket who are both observed within the bunching region could either both be bunching just below the tax threshold or just above it. Couples in different tax brackets could also both be bunching, but each

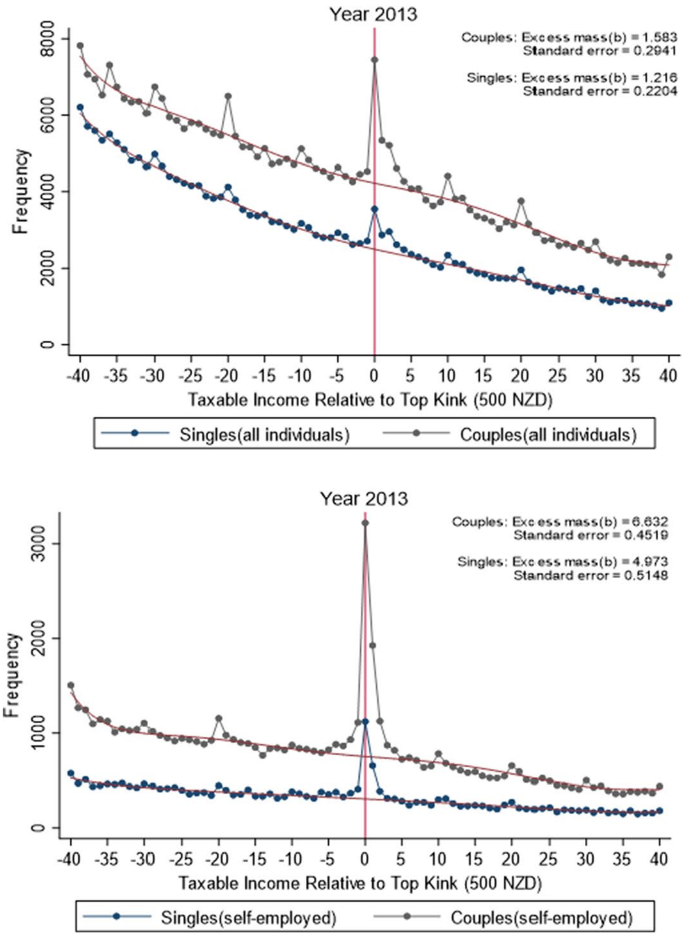

Fig. 9 Bunching by taxpayer type: 2013

as expected the self-employed display larger excess mass values than those for all taxpayers, and the excess mass for self-employed individuals in a couple is significantly greater than the excess mass for self-employed singles. Third, estimates of b are all smaller in 2012–2017 compared to 2001–2008. As shown below, this is a markedly different pattern from that observed with ETI values. It is consistent with the reduced tax incentive to bunch following the substantial reduction in the top marginal tax rate from 38 per cent to 33 per cent in 2011: bunching by all groups was much less than bunching prior to the 2011 reforms. Fourth, excess mass estimates for coupled individuals in different tax brackets are

Footnote 53 (continued)

partner is observed just above, and just below, the kink. In either case (same or different brackets), only one member of the couple may be observed to bunch around the top kink while the other partner could be bunching at a lower kink or not bunching at all.

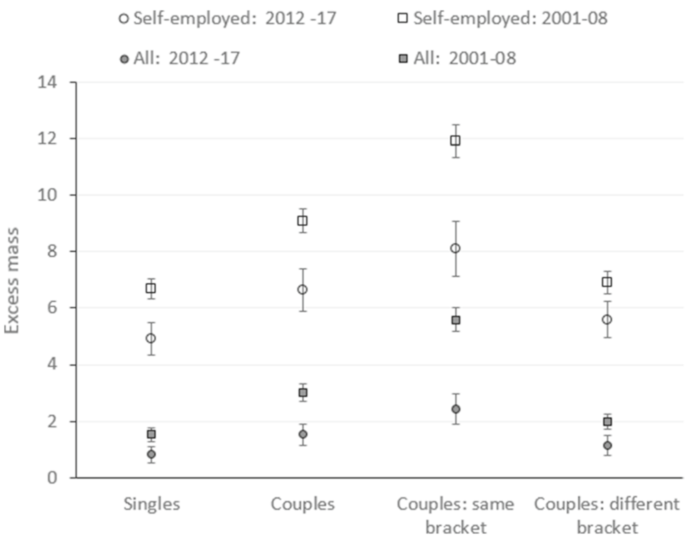

Fig. 10 Excess mass by taxpayer type: 2001–2008 and 2012–2017

Table 10 Excess mass estimates for all individuals

Year	Singles		Individuals in couples					
			All		Same bracket		Different brackets	
	Excess		Excess		Excess		Excess	
	Mass	s.e.	Mass	s.e.	Mass	s.e.	Mass	s.e.
2001	0.944	0.398	2.612	0.328	6.406	0.679	1.246	0.273
2002	0.802	0.376	3.515	0.297	6.715	0.475	2.207	0.280
2003	1.152	0.299	3.656	0.300	7.859	0.573	2.059	0.280
2004	3.090	0.326	4.139	0.285	7.487	0.591	2.888	0.239
2005	2.514	0.260	3.529	0.267	6.026	0.405	2.539	0.290
2006	1.605	0.247	2.862	0.229	4.975	0.397	2.016	0.205
2007	1.422	0.212	2.728	0.221	4.754	0.323	1.890	0.216
2008	0.772	0.198	1.724	0.221	3.296	0.306	1.024	0.219
Pooled								
2001–2008	1.530	0.155	3.011	0.185	5.583	0.256	1.978	0.166
2012	1.066	0.264	1.891	0.297	3.250	0.432	1.380	0.266
2013	1.216	0.220	1.583	0.294	2.782	0.389	1.121	0.269
2014	0.832	0.216	1.719	0.265	2.603	0.367	1.360	0.245
2015	0.697	0.173	1.402	0.244	2.146	0.347	1.092	0.215
2016	0.723	0.172	1.249	0.227	2.117	0.345	0.892	0.198
2017	0.590	0.173	1.379	0.249	2.029	0.365	1.092	0.219
Pooled								
2012–2017	0.827	0.167	1.529	0.237	2.454	0.323	1.153	0.205

t-ratios for all excess mass estimates exceed 2 generally slightly higher than for equivalent singles, though *t*-tests suggest this is only statistically significant (at 5 per cent) for 'all taxpayers' (self-employed plus wage-earners) during 2001–2008. This aspect is discussed further below when considering ETIs.

Appendix 3.3: Annual excess mass estimates

Annual estimates of excess mass for all taxpayers combined, together with associated standard errors, are reported in Table 10 (all taxpayers) and in Table 11 (self-employed taxpayers). These estimates provide more detail than those shown in Fig. 10 for the two pooled sub-samples for 2001–2008 and 2012–2017. The results suggest consistently that excess mass estimates for coupled individuals are greater than for single individuals, and for both taxpayer types excess mass values for the self-employed are much larger than for all taxpayers combined. Following the introduction of the higher top tax rate in 2001, excess mass estimates generally increased over the next three to four years. For self-employed coupled

Table 11 Excess mass estimates for self-employed

Year	Singles		Individuals in couples					
			All		Same bracket		Different brackets	
	Excess		Excess		Excess		Excess	
	Mass	s.e.	Mass	s.e.	Mass	s.e.	Mass	s.e.
2001	6.413	0.558	9.077	0.362	13.270	0.694	6.140	0.381
2002	7.277	0.492	11.180	0.371	13.580	0.806	9.189	0.408
2003	7.329	0.532	10.840	0.480	15.040	0.906	7.612	0.545
2004	8.309	0.558	10.090	0.482	13.680	0.823	7.512	0.433
2005	7.618	0.518	8.414	0.412	10.470	0.571	6.799	0.443
2006	6.107	0.584	8.119	0.402	10.300	0.649	6.416	0.413
2007	4.935	0.439	8.512	0.425	10.840	0.625	6.675	0.455
2008	6.010	0.488	7.594	0.451	10.020	0.579	5.558	0.461
Pooled								
2001–2008	6.692	0.215	9.089	0.256	11.890	0.351	6.905	0.232
2012	4.846	0.509	6.914	0.477	9.169	0.735	5.385	0.460
2013	4.973	0.515	6.632	0.452	8.626	0.659	5.251	0.434
2014	5.100	0.475	6.904	0.531	8.353	0.675	5.843	0.493
2015	5.057	0.450	6.596	0.510	7.723	0.678	5.791	0.458
2016	4.763	0.473	6.226	0.476	7.340	0.626	5.427	0.471
2017	4.763	0.415	6.588	0.550	7.602	0.786	5.811	0.525
Pooled								
2012–2017	4.915	0.354	6.641	0.458	8.104	0.585	5.591	0.394

t-ratios for all excess mass estimates exceed 2 individuals, this seems to have occurred relatively quickly with the highest excess mass value, 11.2, in 2002 before a gradual decline to 7.6 in 2008.

For singles, however, whether self-employed or all singles combined, excess mass values reach a peak in 2004 before declining similarly to 2008. This may reflect greater difficulties experienced by singles, and especially single employees, setting up suitable income-shifting arrangements from 2001, compared to self-employed couples for whom income sharing within the household was relatively low cost following the top marginal rate rise.

During 2012–2017, following the minor (2009) and major (2011) marginal tax rate reductions, annual excess mass values for all taxpayer types remain lower and relatively stable. For the self-employed, all excess mass values appear lower than their values during 2001–2008. This provides some vindication for the 2011 reforms, which were designed in part to improve tax compliance by top rate taxpayers via reductions in the top personal marginal rate, and alignment of that rate with the rate applicable to family trusts, which had been a common destination for diverted income; see Buckle (2010).

Tables 10 and 11 distinguish bunching estimates for partners who are observed in the same, or different, tax brackets. As with the distinction between singles and couples in general, within couple families there are big differences in each year between those with partners in the same or different brackets. Like the pooled evidence in Fig. 10, there is strong support for the hypothesis that excess mass values are higher where partners both earn income in the same bracket. Indeed, for all taxpayers, values for coupled individuals in different tax brackets are similar to those for equivalent single individuals.

Furthermore, the large differences which emerge soon after the 2001 top tax rate increase, tend to diminish during 2003-08, and after the 2011 reform excess mass values are more similar between the two couple types, though differences in annual excess mass estimates remain statistically different. The value of the excess mass is much larger for self-employed couples, almost certainly reflecting the relative ease with which such coupled individuals can reallocate taxable income within the family in response to tax rate differences.

Appendix 3.4: Annual and pooled ETI estimates

Numerical values of ETI estimates are presented in Table 12 for all individuals, and in Table 13 for the self-employed.[54] Results for individuals in different tax brackets are shown in Fig. 11, for self-employed taxpayers and also when combined with wage earners (‘All taxpayers’), with 95 per cent confidence intervals around each estimate. While ETI point estimates for couples in different tax brackets are generally above those for singles, this is not always the case and confidence intervals can be seen to substantially overlap. Indeed *t*-tests of differences between these point

[54] Results from *t*-tests for differences in excess mass estimates between singles and couples and between couples in the same and different brackets in Table 12, confirm that all differences are statistically significant at 5 per cent except for the single-couple excess mass difference in 2013.

Table 12 ETI estimates for all individuals

Year	Singles	Individuals in couples		
		All	Same bracket	Different brackets
2001	0.084	0.232	0.569	0.111
2002	0.071	0.312	0.596	0.196
2003	0.102	0.325	0.698	0.183
2004	0.274	0.368	0.665	0.257
2005	0.223	0.313	0.535	0.226
2006	0.143	0.254	0.442	0.179
2007	0.126	0.242	0.422	0.168
2008	0.069	0.153	0.293	0.091
Pooled				
2001–2008	0.136	0.267	0.496	0.176
2012	0.174	0.308	0.530	0.225
2013	0.198	0.258	0.454	0.183
2014	0.136	0.280	0.424	0.222
2015	0.114	0.229	0.350	0.178
2016	0.118	0.204	0.345	0.145
2017	0.096	0.225	0.331	0.178
Pooled				
2012–2017	0.135	0.249	0.400	0.188

Table 13 ETI estimates for self-employed

Year	Singles	Individuals in couples		
		All	Same bracket	Different brackets
2001	0.570	0.806	1.179	0.545
2002	0.646	0.993	1.206	0.816
2003	0.651	0.963	1.336	0.676
2004	0.738	0.896	1.215	0.667
2005	0.677	0.747	0.930	0.604
2006	0.542	0.721	0.915	0.570
2007	0.438	0.756	0.963	0.593
2008	0.534	0.675	0.890	0.494
Pooled				
2001–2008	0.594	0.807	1.056	0.613
2012	0.790	1.127	1.495	0.878
2013	0.811	1.081	1.407	0.856
2014	0.832	1.126	1.362	0.953
2015	0.825	1.076	1.259	0.944
2016	0.777	1.015	1.197	0.885
2017	0.777	1.074	1.240	0.948
Pooled				
2012–2017	0.801	1.083	1.322	0.912

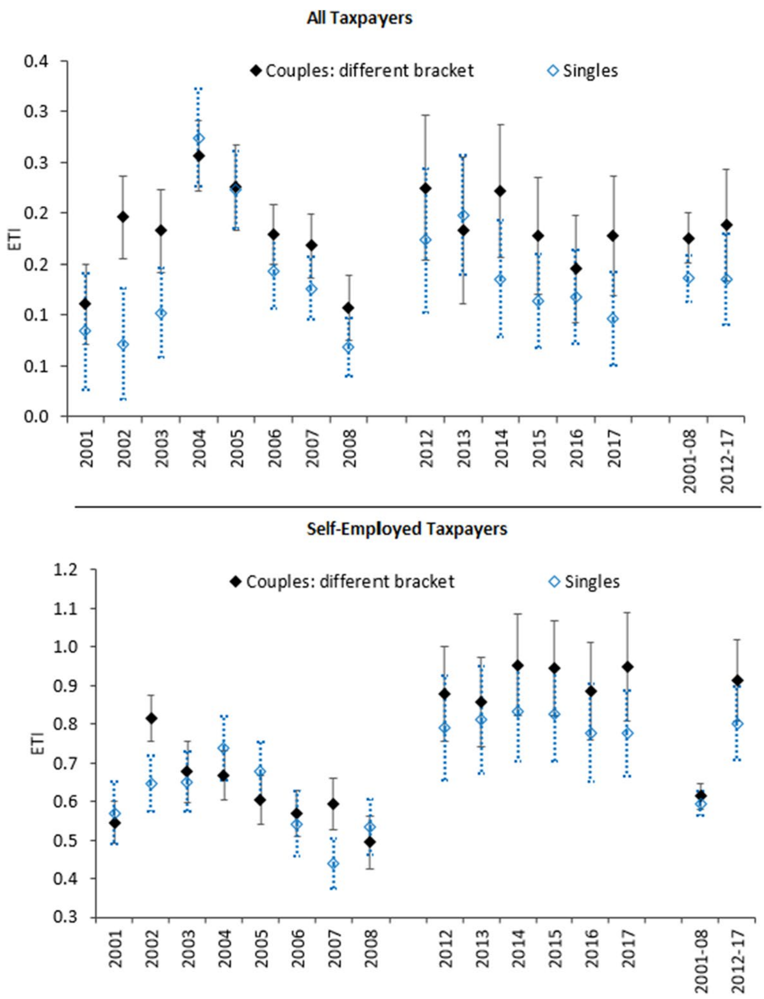

Fig. 11 ETIs for singles versus couples in different brackets

estimates suggest no statistical differences except for the ‘All taxpayers’ groups in 2002, 2003, 2017 and (pooled) 2001–2008, and for self-employed taxpayer differences in 2002 and 2007.

Section 4.3 and Table 4 summarised results from pooled samples for decompositions of the self-employed according to the employment status of their partners. More details on annual and pooled samples are given in Tables 14 and 15, including results from *t*-tests of the hypothesis that excess mass values differ across the two sub-samples of self-employed and wage-earning partners. This confirms that excess mass and ETI values are larger for self-employed taxpayers partnered with other self-employed taxpayers compared to those partnered with wage-earners. For

Table 14 ETI Estimates for different self-employed partner decompositions

Taxpayer:	Taxpayer's partner type[a]						EM t-test
Self-employed	All	(t-ratio)	SE-only	(t-ratio)	WE-only	(t-ratio)	SE=WE[b]
2001	0.806	(25.1)	0.938	(22.7)	0.411	(7.6)	(7.7)
2002	0.993	(30.1)	1.090	(24.1)	0.672	(11.4)	(5.6)
2003	0.963	(22.6)	1.085	(20.7)	0.582	(11.3)	(6.8)
2004	0.896	(20.9)	1.010	(20.6)	0.596	(9.7)	(5.2)
2005	0.747	(20.4)	0.886	(19.0)	0.401	(8.80)	(7.5)
2006	0.721	(20.2)	0.846	(20.0)	0.416	(9.4)	(7.0)
2007	0.756	(20.0)	0.842	(18.9)	0.524	(9.8)	(4.6)
2008	0.675	(16.8)	0.794	(16.3)	0.361	(7.30)	(6.2)
Pooled							
2001–2008	0.807	(35.4)	0.926	(35.0)	0.483	(22.3)	(12.8)
2012	1.127	(14.5)	1.300	(14.7)	0.741	(8.8)	(4.6)
2013	1.081	(14.8)	1.307	(15.1)	0.589	(7.9)	(6.3)
2014	1.126	(13.0)	1.282	(12.4)	0.752	(9.4)	(4.1)
2015	1.076	(12.9)	1.268	(11.7)	0.674	(10.8)	(4.8)
2016	1.015	(13.1)	1.225	(12.4)	0.602	(8.5)	(5.2)
2017	1.074	(12.0)	1.300	(11.1)	0.597	(9.2)	(5.3)
Pooled							
2012–2017	1.083	(14.5)	1.281	(14.1)	0.657	(12.7)	(6.0)

[a] t-ratios in columns 3, 5 and 7 test excess mass (EM) values different from zero.

[b] t-ratio for EM differences between SE-only and WE-only sub-samples

Table 15 ETI Estimates for different Wage-earner partner decompositions

Taxpayer:	Taxpayer's partner type[a]						EM *t*-test
Wage-earner	All	(*t*-ratio)	SE-only	(*t*-ratio)	WE-only	(*t*-ratio)	SE=WE[b]
2001	-0.060	(-1.82)	0.058	(0.88)	-0.078	(– 2.35)	(1.84)
2002	-0.015	(-0.49)	-0.054	(-0.97)	-0.008	(-0.27)	(-0.73)
2003	0.043	(1.48)	0.085	(1.77)	0.036	(1.27)	(0.87)
2004	0.158	(6.71)	0.234	(5.59)	0.147	(6.068)	(1.79)
2005	0.151	(6.08)	0.201	(4.05)	0.143	(6.045)	(1.05)
2006	0.100	(4.78)	0.131	(2.96)	0.096	(4.865)	(0.72)
2007	0.085	(4.38)	0.151	(4.07)	0.076	(3.972)	(1.80)
2008	0.001	(0.03)	0.030	(0.83)	-0.003	(-0.19)	(0.83)
Pooled							
2001–2008	0.069	(4.21)	0.114	(4.69)	0.061	(3.77)	(1.78)
2012	0.119	(2.60)	0.103	(1.63)	0.121	(2.69)	(-0.24)
2013	0.080	(1.75)	0.096	(1.52)	0.078	(1.70)	(0.24)
2014	0.089	(2.31)	0.096	(1.66)	0.088	(2.35)	(0.11)
2015	0.044	(1.27)	0.119	(2.20)	0.034	(1.02)	(1.32)
2016	0.025	(0.72)	0.029	(0.54)	0.024	(0.72)	(0.08)
2017	0.031	(0.87)	0.044	(0.76)	0.030	(0.86)	(0.21)
Pooled							
2012–2017	0.063	(1.89)	0.081	(1.79)	0.055	(1.73)	(0.35)

[a]*t*-ratios in columns 3, 5 and 7 test excess mass (EM) values different from zero.

[b]*t*-ratios for EM differences between SE-only and WE-only sub-samples

the wage-earning taxpayers in Table 15, *t*-tests are less clear-cut (in large part due to the low values of the ETI for most wage-earners). However, there are a number of cases where the ETI for wage-earners partnered with a self-employed taxpayer significantly exceeds (at 5 per cent) the equivalent ETI for two partnered wage-earners.

Appendix 3.5: Bunching specification sensitivity

Further sensitivity testing of the paper's main results to three aspects of the excess mass calculation are reported here: relating to the income class width, the size of the bunching window around the tax kink, and the degree of the polynomial specified in the counterfactual income distribution.

Table 16 considers the effects of reducing the width of the income groups from \$500 to \$250. This doubles the number of discrete observations of both income distributions. To save space only pooled sample estimates, 2001–2008 and 2012–2017 are reported; results for annual estimates are similar. The change in the income group width is shown to have a negligible impact on ETI estimates.

Table 16 reports the effect of changing the bunching window to [±4; ± 6]. Again, ETIs appear to be robust to this change. Unsurprisingly, point estimates are slightly

Table 16 Testing sensitivity to bunching specifications

	Singles	Individuals in couples		
		All	Same bracket	Different brackets
2001–2008				
Baseline[a]	0.136	0.267	0.496	0.176
Income class width: $250	0.138	0.272	0.499	0.181
Bunching window: [− 4, + 4]	0.129	0.260	0.483	0.170
Bunching window: [− 6,+ 6]	0.142	0.273	0.503	0.181
Order of polynomial: 5	0.126	0.263	0.493	0.171
Order of polynomial: 6	0.135	0.267	0.497	0.175
2012–2017				
Baseline[a]	0.135	0.249	0.400	0.188
Income class width: $250	0.142	0.262	0.421	0.197
Bunching window: [− 4,+ 4]	0.122	0.234	0.378	0.175
Bunching window: [− 6,+ 6]	0.141	0.257	0.403	0.197
Order of polynomial: 5	0.109	0.203	0.398	0.150
Order of polynomial: 6	0.134	0.248	0.333	0.187

[a]Baseline: income class width: 500; bunching window: [− 5,+ 5]; polynomial degree: 7

lower when narrower bunching windows are used, and slightly higher for a larger window; for example, ETI = 0.122 for 2012–2017 using the [±4] window, and ETI = 0.141 when [±6] is used (ETI = 0.135 in the baseline case). Furthermore, using a potentially less flexible 6^{th}-order polynomial instead of 7^{th} has almost no effect on the ETI estimates, while reducing the order further, to five, leads to slightly lower estimates.

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