(McAlister, F. et al., 2012)

Average Marginal Income Tax Rates for New Zealand, 1907-2009

Fiona McAlister, Debasis Bandyopadhyay,
Robert Barro, Jeremy Couchman,
Norman Gemmell and Gordon Liao

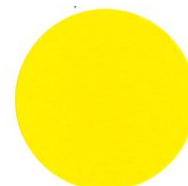| NZ TREASURY WORKING PAPER 12/04	Average Marginal Income Tax Rates for New Zealand, 1907-2009

MONTH/YEAR	September 2012

AUTHOR	Fiona McAlister New Zealand Treasury PO Box 3724 Wellington 6015 NEW ZEALAND Email fiona.mcalister@treasury.govt.nz Telephone 64-4- 917 7022

NZ TREASURY	New Zealand Treasury PO Box 3724 Wellington 6008 NEW ZEALAND Email information@treasury.govt.nz Telephone 64-4-472 2733 Website www.treasury.govt.nz

Abstract

Estimates of marginal tax rates (MTRs) faced by individual economic agents, and for various aggregates of taxpayers, are important for economists testing behavioural responses to changes in those tax rates. This paper reports estimates of a number of personal marginal income tax rate measures for New Zealand since 1907, focusing mainly on the aggregate income-weighted average MTRs proposed by Barro and Sahasakul (1983, 1986) and Barro and Redlick (2011). The paper describes the methodology used to derive the various MTRs from original data on incomes and taxes from Statistics *New Zealand Official Yearbooks* (NZOYB), and discusses the resulting estimates.

Table of Contents

List of Tables

List of Figures

Average Marginal Income Tax Rates for New Zealand, 1907-2009

Executive Summary

Estimates of marginal tax rates (MTRs) faced by individual economic agents, and for various aggregates of taxpayers, are important for economists testing behavioural responses to changes in those tax rates. Numerous research papers testing for impacts of taxes on labour supply, investment, productivity or economic growth use a variety of tax rates applicable at individual or aggregate levels. For macroeconomic level studies of the determinants of economic growth, Barro and Sahasakul (1983, 1986) proposed a method to calculate an 'aggregate' average marginal tax rate (AMTR) faced by personal income taxpayers. This approach was applied to US data by Barro and Sahasakul (1983, 1986), and more recently by Barro and Redlick (2011), to identify impacts of marginal tax changes on GDP growth. These calculated rates largely avoid the endogeneity problems of more commonly used aggregate-level MTRs based on tax revenue data.

This paper adapts the methodology proposed by Barro, Sahasakul and Redlick to derive a similar aggregate marginal tax rate measure for New Zealand. This involves construction of an income-weighted average of individual-level marginal tax rates, having first accounted for various factors that allow effective, rather than statutory, marginal tax rates to be estimated.

We construct the AMTR measure for 1907-2009. Our approach is largely dictated by data availability – Statistics New Zealand income distribution and tax data for 1907-1981 and Inland Revenue taxpayer unit record data for 1981-2009 (with a 3 year overlap period, 1981-1983 as a cross-check). We combine data on the income tax schedule, taking account of income tax rates, thresholds, exemptions etc, with data on the distribution of incomes and exemptions from Statistics New Zealand's *Official Yearbook, Report of Incomes and Income Taxes,* and *New Zealand Censuses.* These sources enable AMTRs to be calculated for most years from 1907-1983, with varying degrees of accuracy.

The resulting AMTR evidence shows that the nature of the tax schedule has changed dramatically over the period, and the contribution of income weighting from different income classes of taxpayers has also played a role. The AMTR series varied substantially over the whole 1907-2009 period, but with a generally increasing trend. Unsurprisingly, the AMTR rose especially during the two World Wars, fell modestly in the immediate aftermath of war but soon stabilised, or rose again quickly thereafter. After the immediate post-WWII reduction, the AMTR increase from around 25% in the mid-1940s to around 45% by the early-1980s, with a major interruption when AMTRs declined in 1961 and, to a lesser extent, in the early 1970s. From the early 1980s a substantial decline in the AMTR occurs, in part associated with the later '80s reforms, reaching under 30% by 1990. The data also confirm the small but sustained rise in the AMTR (from 26% in 2000 to 31% in 2008) following the increase in the top rate of personal income tax from 33% to 39% in 2000, and the impact of fiscal drag thereafter as income tax thresholds remained fixed in nominal terms.

An Excel spreadsheet containing all of the main estimated tax rates accompanies this paper.

1   Introduction

A focus on marginal tax rates (MTRs) is ubiquitous among studies of the numerous economic outcomes that can be affected by taxation. The 'outcomes' of interest are often at the individual taxpayer level; eg, labour supply choices, personal taxable incomes, consumption-savings choices, individual welfare costs. The aggregation of these micro-level behaviours in response to MTRs into macro-level outcomes has become an important focus of research in recent years. It includes a now extensive literature on the effects of taxation (and public expenditure, deficits, etc) on aggregate GDP, national savings, investment, and other macro-level outcomes.

The recent global financial crisis in particular has prompted macroeconomists to reconsider the effectiveness or otherwise of fiscal stimulus packages on GDP and other macro variables, with analysis and evidence on this issue dominating recent debate in the US over the merits of tax cuts and stimulus spending. Similarly, for New Zealand, recent tax and spending reforms, including changes to key MTRs have implications for net fiscal injections and future fiscal deficits. In addition, the literature testing the impacts of fiscal policy on longer-run economic growth has increasingly investigated the importance of MTRs faced by different agents and types of economic activity, and the impact of exogenous changes in public expenditures.[1]

Among the difficulties confronting those macro-level studies are problems measuring the 'true' marginal tax rates of interest. Lack of suitable data has often meant that 'implicit' average tax rates are used, obtained using tax *revenue* data. As a consequence, the endogenous relationships among 'true' marginal tax rates, tax bases and GDP - (which together determine tax revenues) - become difficult to disentangle. Recently Barro and Redlick (2011) have proposed ways to help overcome these endogeneity concerns. First, they estimate multiplier effects on US GDP over a long period (1917-2006) and consider both taxes and public spending simultaneously. For the latter they use public *defence* expenditures and *expected* defence expenditures ("defence news") to help overcome spending endogeneity. This requires a number of war episodes to assist with identification. Second, on the tax side, following methods developed by Barro and Sahasakul (1983, 1986), they argue that an economy-wide 'average marginal tax rate' (AMTR) using taxpayer income shares as weights provides a suitable marginal tax rate measure to capture the potential aggregate responses of GDP to changes in individual personal tax incentives.

The present paper reports estimates of a number of MTR measures for New Zealand, focusing especially on the Barro and Sahasakul AMTRs for personal income taxes. The estimates cover around a century of New Zealand's personal income tax regime, from 1907 to the present. The paper contributes to the literature in three main areas. First, we provide a comprehensive time-series database of various marginal income tax rate variables over more than 100 years. We calculate effective marginal income tax rates by adjusting for various additional taxes (social security, war taxes etc) and exemptions. The inclusion of the impact of social welfare benefits was beyond the scope of our analysis; however, we have provided a point estimate for 2008. Second, we extend the limited database on incomes (available from Inland Revenue from 1981) to include aggregate level income data by income class from 1907 assembled from Statistical Yearbooks and other primary sources. Third, we propose a methodology to construct a Barro-Sahasakul type measure of AMTRs using the data available for New Zealand. This dataset has the potential to form a useful basis from which to answer a number of empirical questions relating to the output effects of fiscal policy in New Zealand.

---

[1] Recent contributions include Lee and Gordon (2005), and Angelopoulos et al. (2007), Romero-Avila and Strauch (2008), Romer and Romer (2010), Gemmell et al (2011a,b), Beetsma and Guiliudori (2011), Arnold et al (2011), Ramey (2011).

The paper is organised as follows. Section 2 discusses New Zealand's personal income tax system, putting it in historical perspective. Sub-section 2.1 begins by putting the income tax in the context of New Zealand's overall revenue-raising regime of which income taxation was initially only a small part. Since a number of tax rate definitions are used throughout the paper, sub-section 2.2 introduces those definitions, including the Barro-Sahasakul AMTR measure. In view of the important role of income-weighting in the AMTR measure, section 3 introduces the available income data and its distribution across income classes over the period. Section 4 then describes the methodology used to construct the AMTR series for New Zealand, and section 5 presents and discusses the AMTR results.

2   Personal Income Taxation

This section first shows how income taxation has evolved within the New Zealand tax system since the beginning of the twentieth century, introduces a number of marginal tax rate definitions used later in the paper, and discusses some key historical aspects of the New Zealand income tax system that affect calculations of the various MTR measures.

2.1   Sources of Government Revenue

Over the course of New Zealand's fiscal history the sources of government revenue have changed as the economy has developed and the role of government increased. While taxation is only one source of government revenue, it is the most important, though the proportions of expenditure financed by taxes, charges for services and borrowing have varied considerably over the years.

The composition of tax revenue has changed significantly over the last century. In the early colonial period it was based heavily on customs and excise duties; these accounted for more than 90 percent of tax revenue in 1875-76, with the balance being provided by stamp duties. Excise duties were charged on commodities such as alcohol, tobacco and sugar.[2] At that stage in New Zealand's history customs duty acted similarly to a general sales tax on commodities since a very high proportion of commodities was imported.

In the last years of the nineteenth century taxation was extended into two new areas: an excise on beer, and taxes on land and property. Customs and excise duties remained the predominant source of revenue, but from 1891 income was introduced as a new tax base in the Land and Income Tax Act. Nevertheless, during the early part of the twentieth century the government continued to rely on customs and excise duties for revenue, and it was not until the on-set of the First World War (WWI) that income taxes began to contribute a substantial share of total revenues.

These trends can be seen in Figure 1 which shows the changing composition of the tax revenue base from 1903 to 2011.[3] Taxes are split into customs and excise duties, personal income tax, company income tax, land tax, estate and gift duties, and 'other taxes'.[4] Note that data on the revenue share of sales and company taxes is not available before 1950. The Figure shows that over an extended period, the share of customs and

---

[2]   See Goldsmith (2008) for data on tax revenue shares during the nineteenth century from 1840.

[3]   The figure uses data from several different sources. From 1903 to 1949 data is taken from *New Zealand Official Yearbooks*. These did not include categories for company tax or sales tax. From 1950 to 1979 data is from the *New Zealand Planning Council* (1979) and included company and sales tax. From 1980 to 2011 data is taken from *New Zealand Official Yearbooks* and the Government's *Financial Statements*.

[4]   Other taxes included: motor vehicle frees and road user charges, withholding taxes, gaming duties and entertainment taxes.

excise duties fell - from 74% of tax revenue in 1903 to 7% in 2011. The largest falls were associated with WWI, the early 1930s depression and around World War II (WWII).

Land tax also fell from a high of around 15% of revenue in 1910 to close to zero by the 1940s, with the largest declines occurring in the 1930s as 'other taxes' became more important. Estate and gift duties similarly became less significant over time, making up only 1% of tax revenue by 1979 and 0% by 2011. The first broad-based sales tax was introduced in 1933, at 5% of the value of the goods sold.

Figure 1 – Government tax revenue by source, 1903 – 2011

There was a large increase in the revenue share of personal income tax over the period, rising from 6% of total taxation in 1903 to 67% by 1981, before falling to 46% in 2011. Not surprisingly, WWI brought about a substantial increase in the personal income tax share with some of this being reigned back again in the 1920s. The further boost to the income tax associated with WWII (when the income tax share reached around 45%) appears to have been followed by a fairly steady increase in the personal income tax share, largely at the expense of customs and excise duties.

Income taxes continued to increase as a proportion of government revenue in the post-war period until the early 1980s. A large part of this increase was as a result of fiscal drag. Pay As You Earn (PAYE) was introduced for income tax in 1958 which reduced the administrative burden of income taxes. The 1980s then saw a reduction in the reliance on income tax for government revenue, especially in association with the mid-to-late 1980s reforms.

Consumption taxes increased to fill the gap: a comprehensive goods and services tax (GST) was introduced in 1986, initially at 10%, subsequently increased to 12.5% in 1989 and, more recently, to 15% in 2010. As a result the sales tax/GST share rose from around 10% of revenue in 1986 to 26% by 2000.

In common with many other OECD countries, the size of New Zealand's tax revenue as a proportion of GDP has also increased markedly since the early 19th century. In 1900 tax revenues were approximately 8% of GDP. They rose to 28% of GDP during WWII and to a high of 37% in 2006. Currently tax revenues make up around 29% of GDP.

excise duties fell - from 74% of tax revenue in 1903 to 7% in 2011. The largest falls were associated with WWI, the early 1930s depression and around World War II (WWII).

Land tax also fell from a high of around 15% of revenue in 1910 to close to zero by the 1940s, with the largest declines occurring in the 1930s as 'other taxes' became more important. Estate and gift duties similarly became less significant over time, making up only 1% of tax revenue by 1979 and 0% by 2011. The first broad-based sales tax was introduced in 1933, at 5% of the value of the goods sold.

Figure 1 – Government tax revenue by source, 1903 – 2011

There was a large increase in the revenue share of personal income tax over the period, rising from 6% of total taxation in 1903 to 67% by 1981, before falling to 46% in 2011. Not surprisingly, WWI brought about a substantial increase in the personal income tax share with some of this being reigned back again in the 1920s. The further boost to the income tax associated with WWII (when the income tax share reached around 45%) appears to have been followed by a fairly steady increase in the personal income tax share, largely at the expense of customs and excise duties.

Income taxes continued to increase as a proportion of government revenue in the post-war period until the early 1980s. A large part of this increase was as a result of fiscal drag. Pay As You Earn (PAYE) was introduced for income tax in 1958 which reduced the administrative burden of income taxes. The 1980s then saw a reduction in the reliance on income tax for government revenue, especially in association with the mid-to-late 1980s reforms.
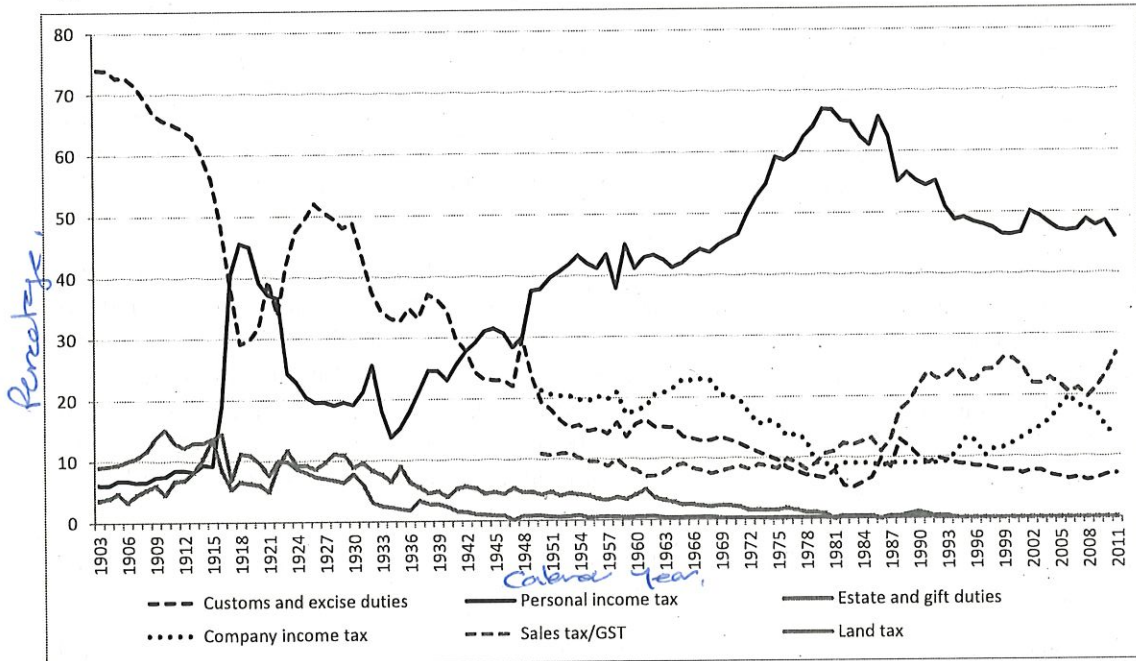
Consumption taxes increased to fill the gap: a comprehensive goods and services tax (GST) was introduced in 1986, initially at 10%, subsequently increased to 12.5% in 1989 and, more recently, to 15% in 2010. As a result the sales tax/GST share rose from around 10% of revenue in 1986 to 26% by 2000.

In common with many other OECD countries, the size of New Zealand's tax revenue as a proportion of GDP has also increased markedly since the early 19th century. In 1900 tax revenues were approximately 8% of GDP. They rose to 28% of GDP during WWII and to a high of 37% in 2006. Currently tax revenues make up around 29% of GDP.

2.2 Tax Rate Definitions

This sub-section defines the key tax rates used in this paper. At the individual taxpayer level most personal income tax systems specify a 'schedule' of statutory marginal tax rates (MTRs) that describe the increase in tax liability associated with an additional dollar of income across different income ranges.[5] In typical progressive income tax systems these statutory MTRs rise in 'steps' with income.

Effective marginal tax rates (EMTRs) refer to the *de facto* increase in tax liability associated with increases in incomes. These are affected by both the statutory MTR and other aspects of the tax code, such as eligible deductions against tax, that affect the taxpayer's tax liability as income rises. Common examples are the withdrawal of tax exemptions or social welfare payments in association with changes in income, and additional taxes (such as supplementary 'war taxes') that are related to income tax liabilities. The EMTRs reported in this paper do not take into account the impact of withdrawal of social welfare payments, but they do include the impact of tax exemptions and additional taxes.

As we discuss below, the New Zealand income tax and transfer system has at various times: (i) set different marginal tax rates for earned and unearned income; (ii) used income-tested exemptions, benefits and rebates, such as Family Tax Credits; and (iii) adopted additional income-related taxes such as social security tax and tax deductions associated with family-owned trusts or companies. In addition, legislative changes to levels of tax-exempt income, even where these exemptions are not directly income-related, can nevertheless move taxpayers into different income tax brackets, and hence the EMTRs that they face, on a given gross (pre-exemptions) income.

Consider a simple tax schedule with only one (non-zero) marginal tax rate, t_1, and where no tax is liable on incomes below an initial tax-exempt level, a, such that:

$$T(y) = t_1[y - a], \qquad \text{for } y > a \qquad (1)$$

where t_1 is the statutory marginal tax rate, T is total tax paid on income, y, and a is the tax exempt income level. If, in addition, the level of the tax-exempt income, a, is reduced at rate v per unit of income as income rises above y_a (where $y_a > a$), then, for $y > y_a$, the effective marginal rate is given by $t_1 + v$, until $a = 0$. Further, for given income levels, a decision to increase the *level* of a that leads to $y < a$, will reduce the taxpayer's EMTR from t_1 to zero. The individual's average tax rate (ATR) for the schedule in (1) is then given by:

$$T(y)/y = t_1[y - a)]/y \qquad \text{for } y > a. \qquad (2)$$

Hence the ATR in (2) must be less than the marginal rate, t_1, if $a > 0$. An equivalent *effective average tax rate* (EATR) - that takes into account any transfer payments ('negative taxes') received - can also be lower than the ATR, depending on the size of the transfers received relative to the individual's income level.

Where individual or household level data are available it is common practice to use effective marginal or average tax rates of personal income tax to test for behavioural responses. These can generally be calculated from tax schedule and other information of the sort described above. When working at the aggregate level, however, the choice of an aggregate equivalent to individual marginal tax rates is not straightforward and, empirically, is often limited by data availability.

A commonly used aggregate tax rate is the so-called 'implicit' average tax rate, R/Y or IATR, based on data for aggregate tax revenue (R) and an aggregate income measure

---

[5] The legal and economic issues surrounding the definition and measurement of 'income' for tax purposes are not explored here.

(Y). A marginal equivalent, or dR/dY, is also sometimes calculated. These 'implicit' rates are widely recognised as unsatisfactory proxies for their conceptual equivalents, but are readily calculated from generally available data. As Myles (2009b, p.34) notes such an aggregate average or constructed marginal rate "probably does not [reflect] the rate that any particular economic decision maker is facing". This is because the IATR is likely to include changes in the income tax base in response to the 'true' EMTR, and hence the IATR measure is not independent of income. Such independence is required to reliably measure the response of income to an exogenous marginal tax rate change.

However, Barro-Sahasakul (1983) established the conditions under which aggregate equivalents of individual MTRs can be constructed from individual values. They showed that the correct form of aggregation depends on how taxes affect consumption, and the question of interest. For example, is the investigator interested in the response of income, or of consumption, or of something else, to changes in marginal tax rates? They show that a consumption-share weighted aggregate of individual MTRs provides the correct aggregation of individual MTRs, under certain assumptions about individual's utility functions.[6] Empirically, since individual income data are more readily available than consumption data, they propose an (individual) *income-weighted average* as a proxy.[7] It is this income-weighted average marginal tax rate (hereafter labelled 'AMTR'), that we focus on below; see Barro and Sahasakul (1983, pp.426-7) for more details.

In later sections we present evidence for New Zealand on the Barro and Sahasakul income-weighted AMTRs from 1907 (the earliest date for relevant income data). We also report data on the top statutory MTR, and the top EMTR taking account of other taxes added to, or abated with respect to, the personal income tax. First, since the nature of the personal income tax structure has changed substantially over the years, the next sub-section outlines some of its key features.

2.3   The New Zealand Personal Income Tax

When the New Zealand income tax was first introduced it took the standard multi-step structure in which a set of statutory MTRs are applied across ranges of income covering hundreds or thousands of pounds.[8] Between 1914 and 1939 various other elements were added to the tax schedule whereby, in addition to these 'steps', tax rates were increased - by tiny fractions of a pound - for every additional pound earned. This had a substantial impact on effective MTRs. We discuss each system in turn below.

2.3.1   The early years: 1892-1913

Income tax was introduced in New Zealand in 1892 with a simple three rate structure: 0% for incomes below £300, 2.5% for incomes in the range £300-1,000 and 5% for incomes in excess of £1,000.[9] This simplicity lasted until 1909; as Table 1 shows, complexity soon set in with a set of ten marginal rates introduced in 1910 including a top rate of 5.8%.

---

[6] For some purposes, such as measuring tax impacts on employment or unemployment, a taxpayer-weighted aggregation may be more appropriate.

[7] This consumption or income weighting can be based on a geometric, rather than arithmetic, mean if consumption or income responses to tax rates are expected to take a constant elasticity form.

[8] The New Zealand currency was the NZ Pound till 1967; thereafter the NZ Dollar (converted at $2=£1). The Pound (£) was composed of 20 Shillings (s), with each shilling equal to 12 Pence (d); ie, £1 = 240d.

[9] Tax rates were expressed as shillings (s) and pence (p) per pound (£) of income, where there were 12 pence per shilling and 20 shillings per pound. Hence 2.5% = 6p/£ and 5% = 1s/£. New Zealand's currency was decimalised (to the NZ dollar) in 1967.

Table 1 – Income tax rates, 1910-1912

Annual Income range (in £)	Tax rate (%)[*]	Annual Income range (in £)	Tax rate (%)[*]
Less than 300	0	801 - 900	4.2
301 - 400	2.5	901 - 1,000	4.6
401 - 600	2.9	1,001 - 1,250	5.0
601 - 700	3.3	1,250 - 2,000	5.4
701 - 800	3.8	Over 2,000	5.8

[*] Quoted in the tax code in shillings and pence per pound of income

This structure involves the now familiar 'multi-step tax function' in which the marginal tax rate (MTR) is changed in discrete 'steps' at a set of thresholds covering ranges of income levels – usually, as here, involving progressively rising steps at higher income ranges – but is constant between thresholds. Formally, the multi-step income tax function, with a tax-free income exemption, can be written as:

$$
\begin{aligned}
T(y) \quad &= 0 & 0 < y \le a_1 \\
&= t_1(y - a_1) & a_1 < y \le a_2 \\
&= t_1(a_2 - a_1) + t_2(y - a_2) & a_2 < y \le a_3
\end{aligned}
\tag{3}
$$

and so on, where t and a are the statutory tax rates and income thresholds respectively.

2.3.2 The multi-slope tax system: 1914-1939

The structure in (3) was the structure of the NZ personal income tax system prior to 1914 and from 1940. However, from 1914-1939 the tax schedule involved an increasing tax rate for every additional pound of income. To distinguish it, we refer to this below as a 'multi-*slope* tax function' since it involves an upwardly sloping marginal rate function between different income thresholds. In New Zealand it typically applied to incomes in excess of an initial threshold income level (ie, a_1 in (3) above) and, as an individual's income increased, the higher rate applied to *all* income (above an initial exemption where applicable), not just the increment; see Vosslamber (2009, p. 304). Thus the apparent marginal rate in the schedule did not specify the 'effective' marginal rate since an additional pound of income brought with it an additional tax liability on that pound and all previous pounds above the initial exemption level. In addition, from 1917, this initial exemption level was abated (withdrawn) at £1 for every additional £1 of income in excess of £600, further adding to the 'true' marginal rate over this income range.[10] This system is described in more detail in Appendix 1.

2.3.3 Other aspects of New Zealand's income tax structure

It is not possible here to catalogue the numerous changes to the income tax system from 1907 to the present, but a number of milestones in the evolution of the New Zealand income tax structure are worth noting. Those of relevance to AMTR estimates include:

i   The introduction of various exemptions in addition to the 'general exemption'. These included exemptions for children and other dependents and a life insurance exemption (see Appendix 3 for details).

---

[10] This abatement regime operated from 1917 to 1926. Two other abatement regimes were in place from 1927-1930 and 1931-1935. More details are in Appendix 3. A supplementary 'special war tax' was also introduced during 1917-20 which effectively applied a multiplier of 1.3333 to all tax rates (eg, 6% becomes 8%).

Appendix 1: The NZ 'Multi-Slope' Income Tax System 1914-1939

This Appendix describes the so-called 'multi-slope' marginal tax rate schedule. This is in contrast to the more usual 'multi-step' tax schedule in which marginal tax rates rise in steps at specified income thresholds and are constant between thresholds, and where each MTR applies to *additional* income above each threshold. The multi-slope tax schedule of 1914-39, on the other hand, typically applied to incomes in excess of an initial threshold income level but the marginal tax rate specified in the schedule increased with every additional pound that an individual earned and each higher rate applied to *all* income (above an initial tax-exempt level of income where applicable), not just the increment.

Below we describe this system using two years to illustrate: 1914 and 1917. The 1917 case involved two additional features: an additional 'special war tax' (1917- 1920) and an initial income exemption abated beyond a specified higher level of income.

A1.1 The 1914 tax structure

Let y be taxable income before the exemption, A. An exemption of 300 pounds applies for all taxpayers. Let τ^* be the marginal tax rate specified in the tax schedule as levied on assessable income, so that the total tax paid is:

$$T = \tau^*(Y - a) \text{ where } a = 300 \tag{A1}$$

The marginal tax rate, from (A1), is:

$$\tau = dT/dy = \tau^* + (y - a)(d\,\tau^*/dy) \tag{A2}$$

For $300 \leq y \leq 400$: $\tau = \tau^* = 0.025$ (6 pence per pound; there are 240 pennies in a pound)

For incomes above 400, the value of τ^* increases by 3/400ths of a penny for each pound increase in income. Hence:

For $400 < y \leq 1400$:

$$\tau^* = 0.025 + (3/400)(1/240)(y-400)$$

$$\Rightarrow \quad \tau^* = 0.0125 + 0.00003125y \tag{A3}$$

Note that $\tau^* = 0.025$ at y=400 and $\tau^* = 0.05625$ at y=1400. Using (2) and (3) it can be shown that:

$$\tau = 0.003125 + 0.0000625y \tag{A4}$$

giving $\tau = 0.028125$ at y=400 and $\tau = 0.090625$ at y=1400. Values of τ for 400 < y < 1400 are on a straight line between these two points; see Figure 1.

For $1400 < y \leq 2400$, the lower rate of increase in τ^* (1/(400*240)) yields:

$$\tau^* = 0.04168 + 0.000010417y \tag{A5}$$

such that $\tau^*= 0.05625$ at y=1400 and $\tau^*= 0.0667$ at y=2400. For this income range, using (2) and (5) it can be shown that:

$$\tau = 0.038552 + 0.000020834y \tag{A6}$$

Equation (6) yields: $\tau = 0.06772$ at y=1400 and $\tau = 0.08855$ at y=2400. Values of τ for y between 1400 and 2400 are on a straight line between these two points. Beyond 2400, the marginal tax rate is specified as a constant 14 pennies per pound, or 5.83%.

This reveals that the EMTR can be higher, and sometimes considerably higher, than τ^* during the 1914-39 period due to the impact of the multi-slope aspect of the schedule. The

maximum rate does not generally apply at the highest income levels, where the 'slope aspect' is absent. The slope is further amplified when there is abatement of the tax-free threshold, a_1, as occurred during 1917-35.

Figure A1 also reveals that the EMTR varied between about 2.5% and 9% in 1914 for those who were liable to pay tax and file tax returns. Most income earners did not earn sufficient income to exceed the tax-free threshold in this period – by our estimates (see below) only around 10% of employees were tax filers and not all of those were assessed as tax-liable (for example, if their assessable income fell below £300). Hence, when weighted by taxpayer incomes (see section 5), the average 'effective' marginal tax rate across *tax filers* was around 5% in 1914, but for *all* income earners combined it was only around 0.5%.

Figure A1 – Marginal and average tax rates in the 1914 tax structure
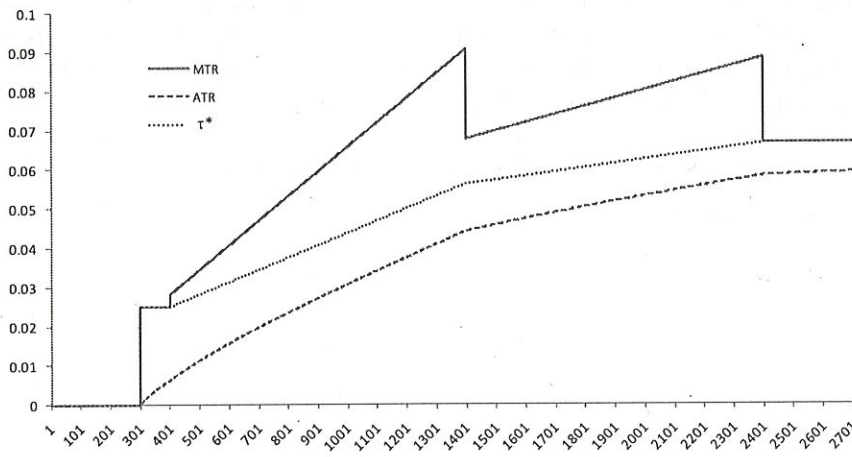
A1.2 The 1917 'war-time' tax structure

The tax structure described above also applied in 1917, with an exemption of £300 available to all taxpayers with incomes below £600. Thereafter the exemption was withdrawn at a rate of £1 each additional £1 earned; ie, the exemption is zero for incomes above 900. (For other years there were different withdrawal regimes, sometimes involving more than one withdrawal or abatement rate).

The marginal tax rate, from (1), now needs to reflect that $d(y - a) \neq dy$, hence:

$$\tau = dT/dy = \tau^*(d(y - a)/dy) + (y - a)(d\tau^*/dy) \tag{A7}$$

Allowing for the abatement range of incomes (600 to 900), this gives:

$$
\begin{array}{llll}
\tau = \tau^* + (y - a)(d\tau^*/dy) & y \le 600 & \text{where } d(y - a)/dy = 1 & \\
\tau = 2\tau^* + (y - a)(d\tau^*/dy) & 600 < y \le 900 & \text{where } d(y - a)/dy = 2 & \text{(A8)} \\
\tau = \tau^* + y(d\tau^*/dy) & y > 900 & \text{where } a = 0;\ d(y - a)/dy = 1 &
\end{array}
$$

For $300 \le y \le 400$, the tax schedule specified a tax rate of 6 pence per pound (0.025) plus a 'war tax' rate of 9 pence (0.0375). The combined marginal tax rate is given by:

$$\tau = \tau^* = 0.0625 \quad \text{(6+9 pence per pound)}$$

For $400 \le y \le 600$, the 6 pence per pound tax rate is increased by 1/200th of a penny per pound and the special war tax rate is increased at 3/400ths of a penny per pound. This gives:

$$\tau^* = 0.041667 + 0.000052083y \tag{A9}$$

yielding: $\tau^* = 0.0625$ at $y = 400$, and $\tau^* = 0.0729$ at $y = 600$. Using (A2) and (A9) it can be shown that $\tau = 0.02604 + 0.00010417Y$, and hence $\tau = 0.0677$ at $y = 400$, and $\tau = 0.0885$ at $y = 600$.

For $600 \leq y \leq 900$, the abatement of the £300 exemption begins; therefore using (A8) and the previous definition of τ^* yields:

$$\tau = 0.03646 + 0.00020833Y \qquad\qquad (A10)$$

In this case: $\tau^* = 0.0729$ and $\tau = 0.1615$ at $y = 600$, while $\tau^* = 0.0885$ and $\tau = 0.2237$ at $y = 900$.

For $900 \leq y \leq 6{,}400$, τ^* is given by the last line of (A8) such that, with no exemptions,

$\tau = 0.1354$ at $y = 900$ and $\tau = 0.7083$ at $y = 6{,}400$. Thereafter, for incomes in excess of 6400 there is no longer any increase in τ^* as incomes increase, That is, $d\tau^*/dy = 0$ and this element of the MTR calculation in drops out. The marginal tax rate is now simply $\tau = \tau^* = 0.375$, implying a large drop in the MTR at $y = 6{,}400$ (from 70.8% to 37.5%) which remains constant at higher income levels; see Figures A1a and A1b.

Figure A2 – Marginal and average tax rates in the 1917 tax structure

A2(a) Individual incomes up to £1200
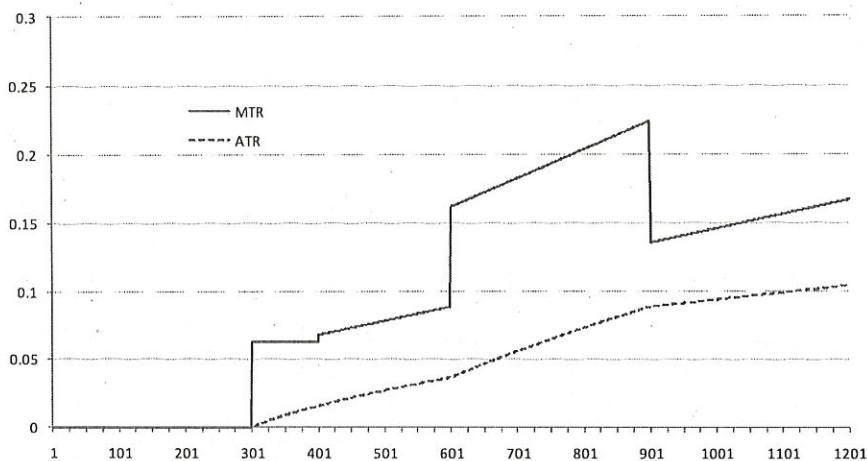
A2(b) Individual incomes up to £7000
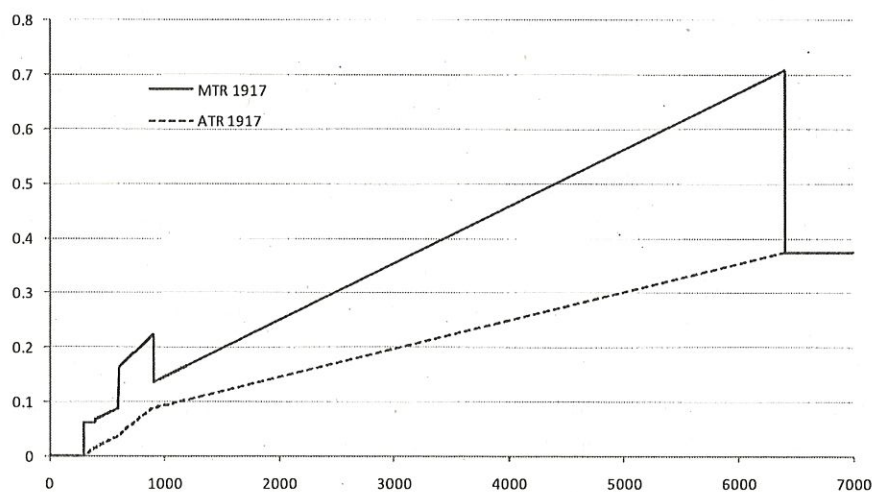
Appendix 2: Income Distribution Data

The income distribution data used in this paper have been sourced from hard copies of various editions of the NZ Official Yearbooks and related Statistics New Zealand publications. Available income and tax data vary in quality and coverage over the period of the personal income tax. There is no income data prior to 1907; thereafter we describe the available data according to different sub-periods.

1907-1924 (Source: NZ Official Yearbooks)

Data in this period are only available for the 1907, 1910, 1912, 1915, 1917, 1920, and 1922-24 income years. The data represent assessable income gathered from tax assessments filed with Inland Revenue. The 1915 and 1923 NZOYBs provide a decomposition of total income (for 1907, 1910, 1912, 1915, 1917, 1920) by salaried persons, persons and firms, registered companies, non-resident traders and professional men. We have combined income distribution data for those groups excluding registered companies to measure personal income.

As noted in the NZOYBs of the early 1920s: "No complete statistics of annual income are available for New Zealand, nor has any official investigation of the total income of the Domain been attempted" (NZOYB, 1925, p.699). Nevertheless, income data based on tax returns filed with Inland Revenue were published in the NZOYB. These return data, particularly in the early 20th century, understate total income because, for many income earners, low income exemptions meant that many taxpayers were excluded from filing tax returns. We have addressed this issue by attempting to estimate non-filer income using long-term labour market data, census data on income and aggregate national income statistics; see below and Appendix 4 for details.

1925 – 1931 (NZ Official Yearbooks)

From 1925 the NZOYB decomposes income into four taxpayer classes (and 10 different sources of income): Class I. Persons and firms (ie, individuals); Class II. Companies; Class III. Agents of debenture holders; and Class IV. Non-resident traders. Importantly, data on the distribution of Class I gross assessable income, by income class size, is available, including similar distributions of earned income and exemptions. Earned income below a given threshold (£2000 in 1929), was taxed at a lower rate compared to unearned income through the first half of the 20th century. In addition, certain income was exempt from tax depending on a taxpayer's circumstances. Data on tax exemptions distributed by size of income, first appeared in the NZOYB in this period; they are described further in Appendix 3.

1932 – 1933 (Source: Estimated)

Data are not available over these two years and it was noted that 'reasons of economy' prevented the data from being collected. We have filled in the missing total and earned income distributions by applying linear interpolation to the income share of each income bracket from the years either side of the missing observations.

1934 – 1941 (Source: NZ Official Yearbooks)

The data discussed above for 1925-1931 are available throughout most of this period. Changes to tax laws in the early 1930s meant individuals with incomes above £200 (formerly £300) were required to file tax returns. As a result it is expected that the NZOYB