

McAlister, Fiona et al.

**Working Paper**

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

New Zealand Treasury Working Paper, No. 12/04

**Provided in Cooperation with:**

The Treasury, New Zealand Government

*Suggested Citation:* McAlister, Fiona et al. (2012) : Average Marginal Income Tax Rates for New Zealand, 1907-2009, New Zealand Treasury Working Paper, No. 12/04, ISBN 978-0-478-39672-0, New Zealand Government, The Treasury, Wellington

This Version is available at:

<https://hdl.handle.net/10419/205623>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



<https://creativecommons.org/licenses/by/4.0/>



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

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

---

NEW ZEALAND TREASURY  
WORKING PAPER 12/04

SEPTEMBER 2012



THE TREASURY  
Kaitohutohu Kaupapa Rawa

New Zealand Government

**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

**ACKNOWLEDGEMENTS**

We are grateful to: Sandra Watson of the Inland Revenue department for undertaking the tax rate calculations for 1981-2009, using IR unit record data; University of Auckland for their contribution via the Research Grant #3627069; and Keith Rankin of the University of Auckland for valuable discussions on the history of the NZ tax system.

**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

**DISCLAIMER**

The views, opinions, findings, and conclusions or recommendations expressed in this Working Paper are strictly those of the author(s). They do not necessarily reflect the views of the New Zealand Treasury or the New Zealand Government. The New Zealand Treasury and the New Zealand Government take no responsibility for any errors or omissions in, or for the correctness of, the information contained in these working papers. The paper is presented not as policy, but with a view to inform and stimulate wider debate.

# 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.

**JEL CLASSIFICATION** H20; H24

**KEYWORDS** Average marginal tax rates; New Zealand

# Table of Contents

---

<b>Abstract</b> .....	<b>i</b>
<b>Executive Summary</b> .....	<b>1</b>
<b>1 Introduction</b> .....	<b>2</b>
<b>2 Personal Income Taxation</b> .....	<b>3</b>
2.1 Sources of Government Revenue .....	3
2.2 Tax Rate Definitions.....	5
2.3 The New Zealand Personal Income Tax .....	6
<b>3 New Zealand Income Distribution Data</b> .....	<b>9</b>
3.1 Income Data.....	9
3.2 Exemptions Data.....	10
3.3 Non-Filer Incomes.....	11
<b>4 Calculating AMTRs – Methodology</b> .....	<b>12</b>
4.1 Applying the Barro-Sahasakul Approach.....	12
4.2 Examples of AMTR calculations .....	13
<b>5 Income-weighted AMTRs: 1907-2009</b> .....	<b>14</b>
5.1 The Overall pattern of AMTRs .....	14
5.2 Relationships between Exemptions, Non-Filed Incomes and AMTRs .....	18
5.3 Decomposing Changes in the AMTRs.....	19
5.4 Earned vs. Unearned Income .....	23
5.5 The Effect of Family Tax Credits, Benefits and ACC.....	24
5.6 Reliability of AMTR Estimates .....	25
<b>6 Conclusions</b> .....	<b>26</b>
<b>References</b> .....	<b>27</b>
<b>Data Sources</b> .....	<b>28</b>
<b>Appendix 1: The NZ ‘Multi-Slope’ Income Tax System 1914-1939</b> .....	<b>29</b>
A1.1 The 1914 tax structure.....	29
A1.2 The 1917 ‘war-time’ tax structure .....	30
<b>Appendix 2: Income Distribution Data</b> .....	<b>32</b>
<b>Appendix 3: Exemptions Data</b> .....	<b>34</b>
<b>Appendix 4: Estimating Non-filers’ Incomes</b> .....	<b>37</b>

## List of Tables

Table 1 – Income tax rates, 1910-1912 .....	7
Table 2 – The AMTR calculations, 1980 .....	13
Table 3 – Average marginal tax rates (in percent), 1907-2009.....	17
Table 4 – Correlation matrix of AMTR changes .....	22
Table 5 – EMTRjs for family tax credits, welfare benefits and ACC .....	24
Table A1 – Abatement of general exemption, 1917-1935 .....	35
Table A2 – Exemptions by size of income for the 1925/26 income year .....	35
Table A3 – Estimated average income of non-filers from 1926 census data .....	37
Table A4 – Estimated non-filer income .....	38

## List of Figures

Figure 1 – Government tax revenue by source, 1903 – 2011.....	4
Figure 2 – Top effective marginal tax rates for New Zealand, 1907-2009* .....	9
Figure 3 – Distribution of total and earned assessable income, 1925 .....	10
Figure 4 – Income distribution and tax structure, 1950.....	14
Figure 5 – AMTRs for New Zealand 1907-2009 .....	16
Figure 6 – Proportions of taxed, exempt and non-filed income, 1907 – 1983 .....	19
Figure 7 – AMTRs and tax exempt/non-filed income, 1922-1983.....	21
Figure 8 – Cross-plot of AMTR and non-zero EMTRj average, 1922-1983 .....	21
Figure 9 – Changes in unweighted averages of EMTRjs and AMTRs, 1922-1983 .....	23
Figure 10 – AMTRs for earned and unearned income, 1922-1956 .....	24
Figure A1 – Marginal and average tax rates in the 1914 tax structure .....	30
Figure A2 – Marginal and average tax rates in the 1917 tax structure .....	31
Figure A3 – Ratio of filers-to-total personal incomes, 1907-1958.....	39
Figure A4 – Decomposition of total personal income into filers/non-filers, 1907-1958.....	39

# 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.<sup>1</sup>

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.

---

<sup>1</sup> 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.<sup>2</sup> 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.<sup>3</sup> Taxes are split into customs and excise duties, personal income tax, company income tax, land tax, estate and gift duties, and 'other taxes'.<sup>4</sup> 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

---

<sup>2</sup> See Goldsmith (2008) for data on tax revenue shares during the nineteenth century from 1840.

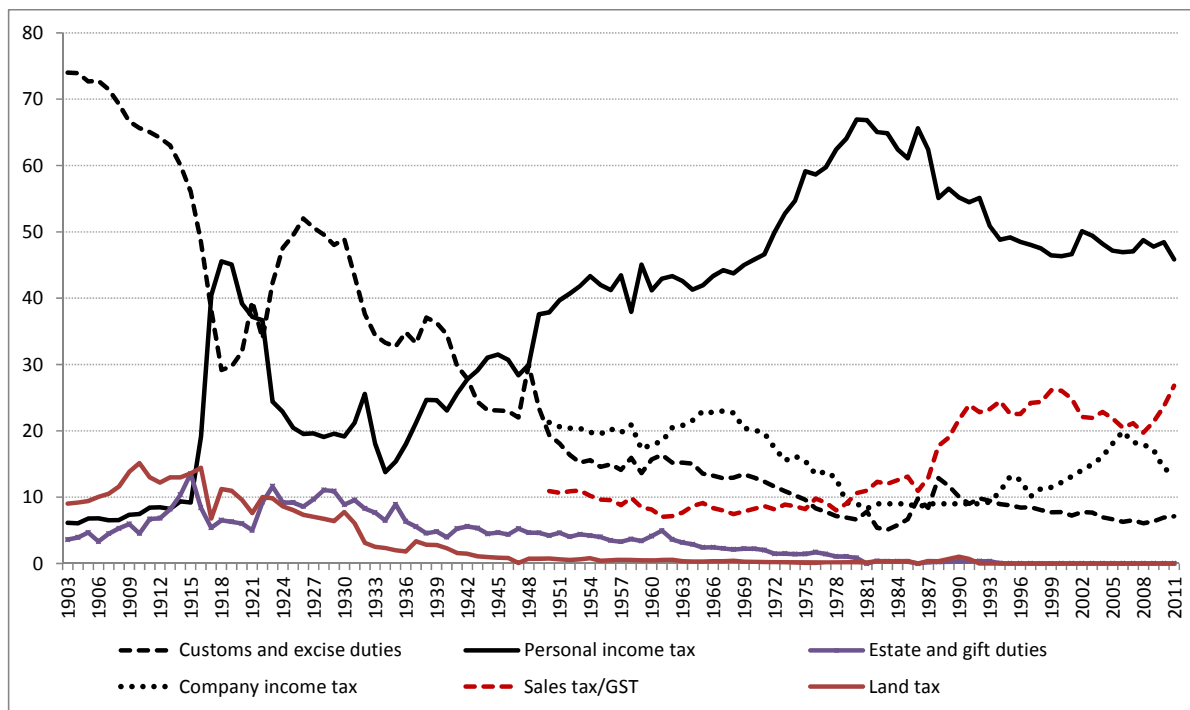
<sup>3</sup> The figure uses data from several different sources. From 1903 to 1949 data is taken from *New Zealand Official Yearbooks*. These did not include categories for company tax or sales tax. From 1950 to 1979 data is from the *New Zealand Planning Council* (1979) and included company and sales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

<sup>4</sup> Other taxes included: motor vehicle fees 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 19<sup>th</sup> 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.<sup>5</sup> 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:

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

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:

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

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

---

<sup>5</sup> 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.<sup>6</sup> Empirically, since individual income data are more readily available than consumption data, they propose an (individual) *income-weighted average* as a proxy.<sup>7</sup> 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 subsection 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.<sup>8</sup> 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.<sup>9</sup> 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%.

---

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

<sup>7</sup> 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.

<sup>8</sup> 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.

<sup>9</sup> 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:

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

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.<sup>10</sup> 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).

<sup>10</sup> 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%).

- ii The distinction made between earned and unearned income from 1921 to 1950.<sup>11</sup> A 10% *discount* on earned income (up to £2000) was in place until 1930, followed subsequently by a one-third tax *surcharge* on unearned income.
- iii A drop in tax rates in the mid-1920s after the WWI ‘temporary’ increases (see Figure 2).
- iv The introduction of a social security tax in 1931 at 1.25%, rising to 12.5% in 1943, then reduced to 7.5% in 1947 and abolished in 1970.
- v The introduction, also in 1931, of an ‘additional tax’ levy, at 30% of the individual’s income tax liability. The additional tax was removed in 1936 but re-introduced for 1939-1953. Over the latter period the rate varied subsequently between 2.5% and 33.3%.<sup>12</sup>
- vi The large increase in EMTRs during WWII with the top rate statutory rate rising to 60%, and a top EMTR approaching 100% (inclusive of social security and special war taxes).
- vii The replacement of the multi-slope income tax schedule with a multi-step function of MTRs in 1940 but with 40 separate rates/steps and a maximum statutory rate of 60%.
- viii Generally lower top statutory rates after WWII until the mid-1970s.
- ix Rises in top statutory MTRs to the mid-1980s followed by the sharp drop associated with the 1980s reforms.

Figure 2 illustrates the decomposition of the top effective marginal tax rate over the period, including the statutory top personal income tax rate plus the ‘additional tax’ component and the social security tax. For the period where the multi-slope function applied, its impact on EMTRs is also shown.

The impact of the ‘additional’ and social security taxes on individual EMTRs is rather different. The relevant expression for an individual’s tax liability can be written as:

$$T(y) = \tau(y - a) + \beta T_1(y) = \tau(1 + \beta)(y - a) \quad (4)$$

Where  $\tau$  is the statutory or effective marginal income tax rate,  $\beta$  is the rate of ‘additional tax’ which is applied to the income tax liability,  $T_1$ , where  $T_1(y) = \tau(y - a)$ . The effective marginal tax rate on income therefore becomes  $\tau(1 + \beta)$ . Letting the marginal social security tax rate be  $s$ , the effective marginal tax rate, EMTR, of all taxes combined is composed as follows:

$$\text{EMTR} = s + \tau + \beta\tau \quad (5)$$

Here  $\beta\tau$  captures the EMTR impact of the ‘additional tax’ levied on the overall income tax liability.

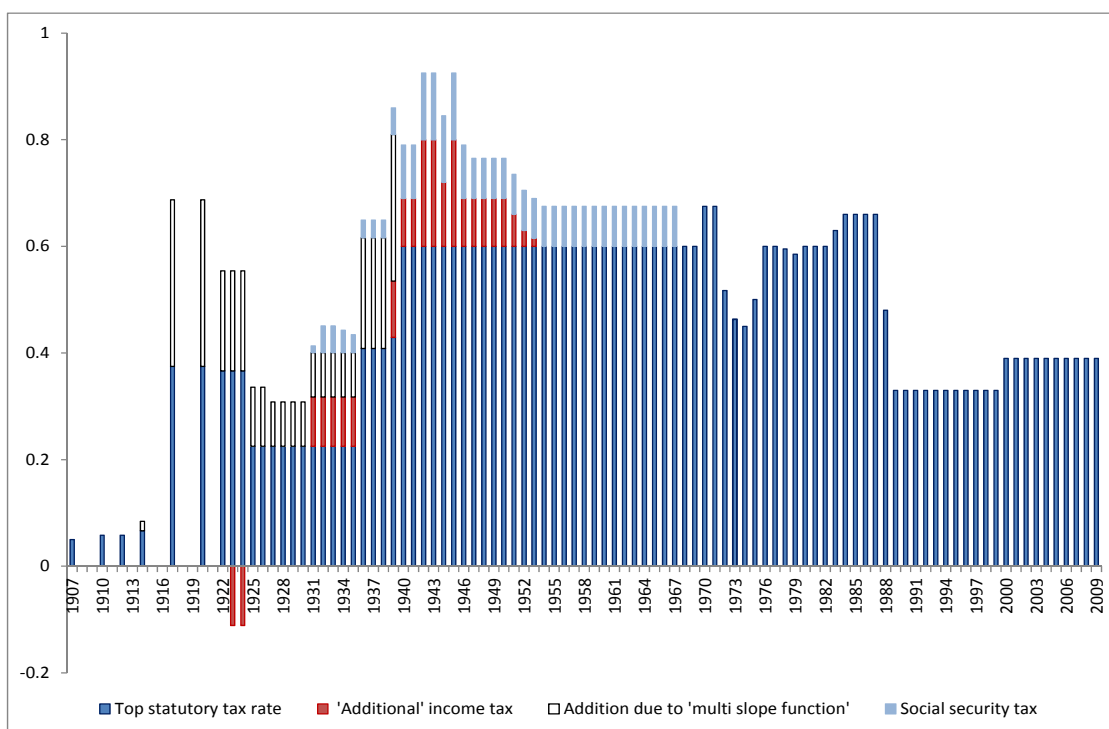
Figure 2 shows how both the social security tax and the additional tax substantially increased effective rates around the WWII period with the additional tax being phased out in the mid-1950s. The social security tax was retained till the late-1960s. For four years during WWII the combined effect of all three taxes produces a top EMTR in excess of 90%: a top IT = 60%; additional tax = 20% (ie, legislation set  $\beta = 0.33$  in those years) and SST = 12.5%.

During the 1920s-30s, the impact of the multi-slope tax schedule on top EMTRs was also substantial, often adding around 15-20 percentage points to those specified in the tax schedule. These high effective rates typically applied at high, but not the highest, income levels (see Appendix 1). In 1923 and 1924 there was a 20% discount on the tax bill, resulting in net a top EMTR of 44%.

<sup>11</sup> Earned income was defined as income earned by a taxpayer through physical exertion (largely salary and wage income), whereas, unearned income relates to passive sources of income such as interest, or rental income.

<sup>12</sup> There had also been a similarly calculated ‘discount’ during 1923-24 at 20%.

**Figure 2 – Top effective marginal tax rates for New Zealand, 1907-2009\***



\* Tax rates shown include social security taxes and relate to earned income where relevant.

Finally, for much of the period studied the amount of tax that individuals paid was also dependent on the amount of exemptions received, which reduced their average tax rates. These can affect individuals' effective *marginal* tax rates directly when they are abated with rising incomes, as discussed above, and indirectly by affecting the number of income earners liable to tax, their assessable income and hence the statutory marginal tax rates applicable for a given gross income. They therefore would shift some individuals across tax brackets and affect *economy-wide* AMTRs as discussed in section 4.

### 3 New Zealand Income Distribution Data

To calculate aggregate level AMTRs requires suitable income distribution data to enable the income-weights to be generated. Income distribution data used here for the purpose of estimating AMTRs have largely been sourced from the *New Zealand Official Yearbooks* (NZOYB), which in turn were sourced from income tax returns filed with Inland Revenue. We have been able to identify data from the early 1900s through to the early 1980s and over this period the data presented in the NZOYBs have evolved. Income data were not separately sourced after the early 1980s. Instead we have utilised AMTRs estimated from more reliable unit record data by Inland Revenue for the period 1981-2009, and we examine a three year overlap as a cross-check on the alternative approaches.

#### 3.1 Income Data

There are three important aspects to the income distribution data for our purposes:

- 1 how income is distributed across the tax brackets/rates for which we have tax schedule information;
- 2 how exemptions against tax are distributed across income levels and tax brackets; and
- 3 how far NZOYB income distribution data, generally only available for tax filers until the PAYE regime from 1958, can be supplemented to capture non-filers' incomes.

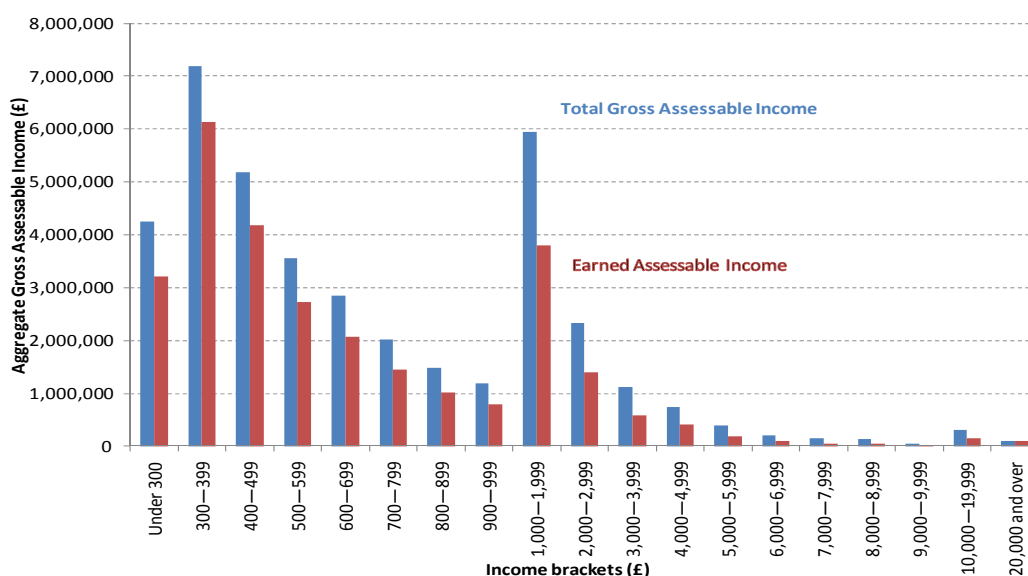
We assembled NZOYB income data on individual taxpayers (for example, wage and salary earners, and self employed), but excluding companies. We focus on the distribution of income for aggregate gross income (before exemptions), aggregate earned and unearned income, and income tax exemptions.<sup>13</sup> We also used data on the number of tax returns filed to estimate the size of non-filed income (see below).

Of course, available income and tax data vary in quality and coverage over the period of the personal income tax, and we have found no suitable income data prior to 1907. Appendix 2 discusses the nature and quality of the income data over various sub-periods during 1907-1983, highlighting the main methods and assumptions adopted.

Figure 3 provides an example of how the income distribution data are organised, in this case for 1925. It shows total assessable income, not numbers of taxpayers, on the vertical axis, with income classes on the horizontal, where the class widths are not standardised. The distribution of gross assessable income is shown with separate histograms for total, and earned, income. Where tax brackets do not coincide with the relevant income classes, aggregate income within the income class is divided on a pro rata basis to allow each segment to be taxed at the appropriate rate. Note that the spike in income in bracket 1,000-1,999 is due to the larger size of this and subsequent brackets.

In 1925, earned income below a certain threshold was taxed at a lower rate compared to unearned income (applicable through the first half of the 20<sup>th</sup> 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 and are described further in Appendix 3.

**Figure 3 – Distribution of total and earned assessable income, 1925**



## 3.2 Exemptions Data

Until the 1970s exemption of some income from personal income tax was a feature of the New Zealand tax system. A portion of income was exempt from tax for a specified set of circumstances, including: low income (the ‘general exemption’), and exemptions for child/dependent, wife/spouse, housekeeper and insurance (related to life insurance and superannuation fund contributions). This had the effect of reducing individuals’ tax

<sup>13</sup> The NZOYB also has data on taxable income (ie, gross income less exemptions), income tax assessed, and similar measures of income and tax for companies. The NZOYB ceased publishing final income data from 1973, though provisional estimates of income were included. Instead, for the 1970s and early 1980s we source income and exemption data from the separate SNZ *Report on Incomes and Income Tax*.



liabilities, for given gross income, depending on their individual circumstances, thereby affecting their *average* tax rates. It directly affected their effective marginal tax rates to the extent that exemptions were income-dependent (eg, were withdrawn in association with increasing income). It would also have affected the relevant statutory tax rate where exemptions shifted a taxpayer between MTR bands. In Appendix 3 we describe the exemptions data further and section 4 below discusses how we use data on the distribution of exemptions by income levels in the AMTR calculations.

### 3.3 Non-Filer Incomes

A major omission from NZOYB income data is the income of individuals who were not required to file tax returns, prior to the introduction of PAYE in 1958. Non-filers were generally those with incomes below the low-income 'general exemption' threshold since those with incomes above this level were legally required to file a return. Appendix 4 describes the methods we use to estimate the income of non-filers. While omission of these non-filers with a zero EMTR would not be a problem for calculations of a tax-share weighted estimate of the aggregate AMTR, it is potentially important for an income-weighted average. Ignoring non-filers would risk over-estimating the AMTR.

In brief, our method of estimating non-filers' income involves using census data for 1926, 1936, 1945 and 1951 and labour market data to derive estimates of total personal incomes which can be compared with our NZOYB data on filers' total personal incomes. One option would be to interpolate between census years using the ratio of filer-to-all personal incomes. This ratio reveals an increasing trend, rising from 0.347 (for 1926) to 0.707 (1936), 0.919 (1945) and 0.963 (1951).

However, evidence from Barro and Sahasakul (1983) suggests that, while this ratio tends to trend up over time in association with rising income levels, it can be especially low during short-run recessionary periods. Within our dataset, this includes the 1920s-30s depression when large falls in personal incomes reduced the numbers of those required to file. Data on GNP are available throughout our period of interest, and this could be expected to capture recessionary impacts.

We therefore estimate the ratio of total personal income,  $Y$ , to GNP in Census years (subscripted 'c'),  $Y_c/GNP_c$ , and use interpolated (subscripted 'i') values of this ratio, and annual GNP values, to estimate values of  $Y_i$  for non-Census years. Together with our estimates for total income of filers,  $Y(F)_i$ , for those years we can estimate non-filers incomes,  $Y(N)$ , in non-Census years as  $Y(N)_i = Y_i - Y(F)_i$ . The resulting time-series for the ratio of filers-to-total income, and the decomposition of total income into filer/non-filer categories, are shown in Appendix 4, Figures A3 and A4 respectively. These suggest a plausible but fluctuating fall in the extent of non-filers' incomes, reaching less than 4% of total personal incomes by 1951.

## 4 Calculating AMTRs – Methodology

### 4.1 Applying the Barro-Sahasakul Approach

As noted in the introduction, the AMTR of interest here is the Barro and Sahasakul (1983) income-weighted average of individual effective marginal personal income tax rates. That is, we want to estimate the aggregate:

$$AMTR = \sum_{j=0}^n \left( \frac{Y_j}{Y} \right) EMTR_j \quad (6)$$

where  $Y_j$  is the personal income of taxpayer  $j$ , and  $Y$  is aggregate personal income across all  $j$  taxpayers. The  $EMTR_j$ s are obtained from the tax schedule or suitably adjusted 'effective' rates where those differ from statutory rates. The relevant tax rates and thresholds are then matched with information on  $(Y_j/Y)$  from our income distribution data, inclusive of the income share of non-filing taxpayers. To avoid confusion, in the remainder of the paper we refer to marginal tax rates (MTR, EMTR) *levied at the individual level* using the subscript  $j$ ; hence:  $MTR_j$ ,  $EMTR_j$ .

Applying equation (6) to our data requires a number of simplifying assumptions. Firstly, from 1981-2009 the use of taxpayer unit record data ensures that the relevant  $MTR_j$  or  $EMTR_j$  of income tax is identified for each taxpayer. However, like the pre-1981 data, this dataset does not include the impact on  $EMTR_j$ s of abatement of social welfare payments.

For data prior to 1981, we seek to match data from NZOYB and other sources on the distribution of gross assessable income with the relevant tax schedule. Since tax brackets are typically described with respect to *net-of-exemptions* assessable income, it is important to subtract those exemptions to identify net income and thereby the appropriate  $EMTR_j$  to apply at each gross income level. For many taxpayers, the deduction of exemptions from their gross income will not alter their  $MTR_j$  or  $EMTR_j$  (eg, deduction of \$5000 from gross income of \$50,000 will not affect the  $MTR_j$  where this  $MTR_j$  applies over a net income band of \$40,000-50,000. However, another taxpayer *with the same \$50,000 of gross income* but \$12,000 exemptions would face a different  $MTR_j$  - that applicable to net income below \$40,000.

We therefore need to deduct exemptions from gross (assessable) income to derive net (assessable) income in order to identify the relevant  $MTR_j$  or  $EMTR_j$  for each taxpayer. However, with aggregate-level, rather than individual-level, gross assessable income and exemptions data by gross income band, we do not know how many taxpayers (and associated fraction of gross income) would face a lower marginal tax rate than would be inferred from their gross income.

Treating our aggregate-level data *as if* they represented an individual within each income band would mean that either all or no income would shift  $MTR_j$  bands as a result of adjusting for exemptions. Instead we (i) assume that the impact of exemptions is to move individuals by no more than one  $MTR_j$  band; and (ii) use the ratio of total exemptions to gross assessable income in each band to weight the  $MTR_j$ s for each band,  $m$ . This yields an  $EMTR_j$  estimate reflecting the exemptions adjustment:

$$EMTR_{j,m} = (e_m/y_m) MTR_{j,m-1} + (1 - e_m/y_m) MTR_{j,m} \quad (7)$$

Where  $(e_m/y_m)$  is the exemptions/income ratio in band  $m$ , and  $MTR_{j,m}$  ( $MTR_{j,m-1}$ ) is the  $MTR_j$  in band  $m$  ( $m-1$ ), ( $m > 0$ ) and  $MTR_{j,0} = 0$ , captures the general personal exemption.

To examine the sensitivity of our AMTR calculations to this assumption, we also report AMTRs where *no* shifts in MTR brackets, based on exemptions data, has been assumed.

## 4.2 Examples of AMTR calculations

Table 2 shows an example of the AMTR calculations – for the 1980 income year – when there were relatively few (six) income tax brackets and MTR<sub>j</sub>s. Since the income tax schedule defines taxable income as income net of exemptions (deductions), the income brackets in row 1 are defined with respect to net income. The MTR<sub>j</sub> for each income bracket is shown in row 2. Row 3 provides an estimate of the EMTR<sub>j</sub> faced by individuals in each tax bracket, adjusted for the impact of exemptions.<sup>14</sup> This adjustment weights the MTR<sub>j</sub>s in each bracket by the ratios of exempt income (row 5) to gross income (row 4). For example, approximately 7% of income in the <4,500 bracket in 1980 was exempt from tax; we therefore assume that this fraction of income faces the MTR<sub>j</sub> of the bracket immediately below; in this case, 0%. In view of the small amount of exemptions (averaging 6% of gross income), the resulting impacts on the 1979/80 EMTRs in row 3 are small.

**Table 2 – The AMTR calculations, 1980**

1	Taxable income bracket (\$)	<4,500	4,500-10,000	10,000-11,000	11,000-16,000	16,000-22,000	>22,000	Total
2	Statutory MTR	14.5%	36.5%	41.5%	48.0%	55.0%	60.0%	
3	EMTR	13.5%	35.2%	41.2%	47.6%	54.6%	59.8%	
4	Gross assessable income	1,225,465	4,565,695	991,170	3,550,580	1,583,880	1,304,220	13,221,010
5	Exemptions	85,775	275,315	66,130	235,960	90,860	45,870	799,910
6	income share (%)	9%	35%	7%	27%	12%	10%	100%

**Income-weighted AMTR = 41.70%**

The relevant gross income shares are calculated in row 6. In principle, non-filer income is also added before estimating the gross income shares in row 6 though, as noted above, this is not relevant after 1958. Applying the row 6 weights to the EMTR<sub>j</sub>s in row 3 yields the AMTR (=41.70%) for 1980. It can be seen that this is dominated by the large shares (nearly 65%) of income in the \$4.5-10k and \$11-16k income brackets facing EMTR<sub>j</sub>s of 35.2% and 47.6% respectively.

The case in Table 2 illustrates a relatively straightforward year. Most years, however, involve multiple marginal tax rates across income levels and a variety of additional complications including:

- i earned and unearned income distinctions (1921-50) with each facing different MTR<sub>j</sub>s<sup>15</sup>
- ii estimation of EMTR<sub>j</sub>s where statutory rates do not measure effective rates; eg, separate non-filer incomes and abatement of thresholds
- iii The multi-slope tax function where EMTR<sub>j</sub>s rise with every pound of income (1914-39); in that case we calculate AMTRs based on EMTR<sub>j</sub>s at the mid-points in income classes across the income distribution
- iv income classes from income distribution data that approximate the income bands in the tax structure, requiring some re-grouping of data on incomes, exemptions etc
- v simultaneous application of several different taxes at various rates to a given income including social security taxes, and special ‘war taxes’

<sup>14</sup> Note that this is not an EMTR as conventionally defined since no individual faces this rate. Rather it reflects the weighted average of rates faced by taxpayers in that, and the adjacent, income brackets.

<sup>15</sup> Data on earned incomes was collected until 1956 but earned and unearned income faced the same tax rate from 1951-1956.

**Figure 4 – Income distribution and tax structure, 1950**

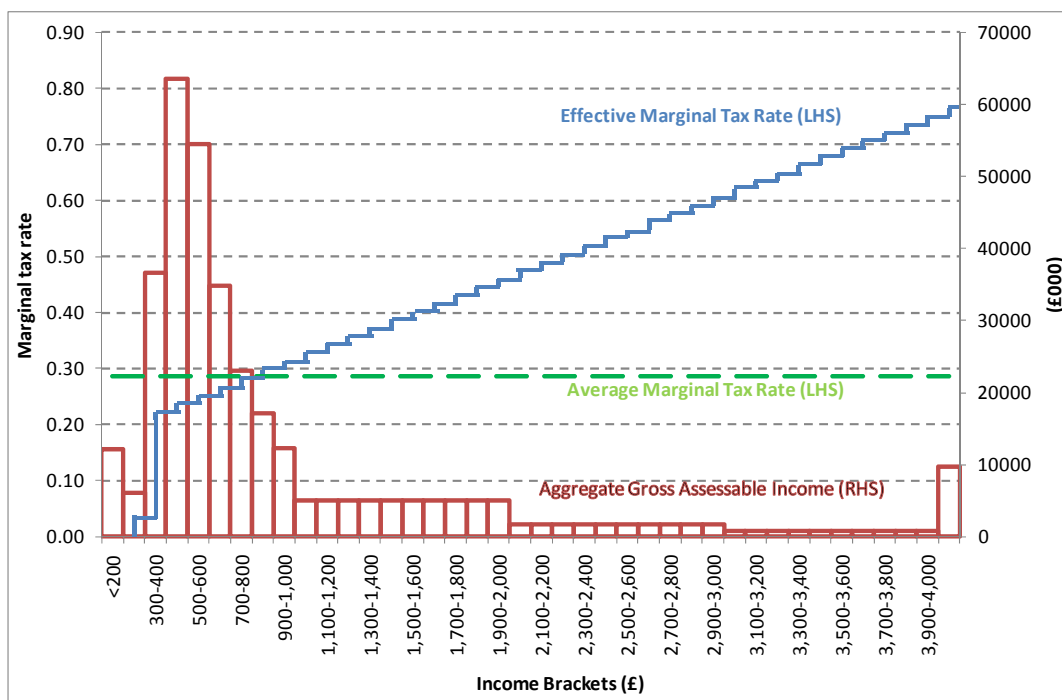


Figure 4 illustrates the more complex 1950 income distribution and tax structure. This overlays income distribution data with the individual EMTRs. The rates rise in multiple steps from 4% at an income of £200 to 76% at incomes over £4000. This yields the AMTR of 29% shown. Exemptions data are used to adjust the EMTRs to approximate the effect of people moving to lower income brackets. This adjustment has a particularly large impact at the bottom of the income distribution; for the £200-300 bracket the effective tax rate drops from 21%, before allowing for exemptions, to 4%. That is, the availability of exemptions shifts a large fraction of taxpayers into the 0% tax rate applied to net incomes up to £200.

## 5 Income-weighted AMTRs: 1907-2009

Using the tax structure and income distribution information discussed in previous sections, this section discusses the estimated values obtained using the methods described earlier – sub-section 5.1. Since the relationship between exempt and non-filer incomes is important for these calculations, this is discussed in sub-section 5.2. Sub-section 5.3 then uses a decomposition of the AMTRs to assess how far changes in tax structure and income levels or its distribution account for observed movements in AMTRs over time.

### 5.1 The Overall pattern of AMTRs

The changes in both the tax schedule and income distribution over the period from 1907 to 2009 have resulted in an AMTR series which varies substantially over the period. Figure 5 shows two AMTR series. The main series (in black) uses exemptions data to adjust the EMTRs up to 1983, and reports IRD-based calculations from 1981. This series is also given in Table 3. A second series ignoring exemptions data (that is, individual EMTRs are not adjusted using exemptions data) is shown in dotted red.

Both series ranges from 0.4% in 1907, the first year for which income distribution data are available, to a maximum of around 47% in 1982. It can be seen that in general the two series follow each other closely suggesting that exemptions adjustments play a limited role. The main period during which exemptions adjustments have a larger impact is 1954

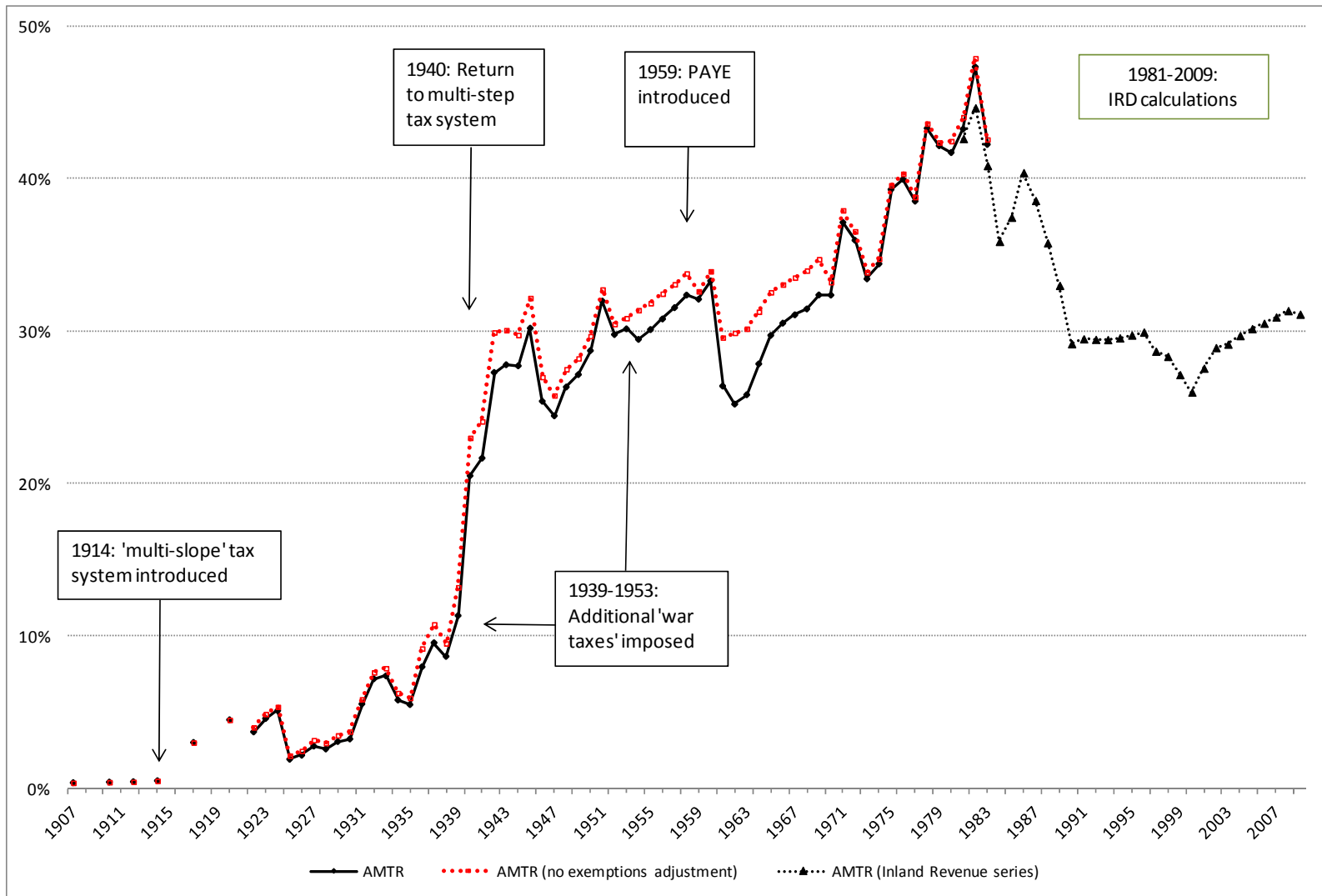
to 1969. As discussed below, this was a period that witnessed a substantial increase in the initial tax-free allowance and other exemptions.

Based on the main series, the AMTR increases during WWI and its aftermath, reaching 5.4% in 1924. It then drops back to 2-3% in the second half of the decade. Thereafter during the inter-war period, the AMTR rises especially during the years of the Great Depression from 1929, reaching a maximum of 7.4% in 1933.

The most significant increase in the AMTR over the century, however, occurs at the beginning of WWII where the rate jumps from 11% in 1939 to 21% in 1940. The AMTR continues to rise thereafter to reach a local maximum of 30% in 1945. Though the AMTR drops in the immediate aftermath of the war, the lower AMTRs over the remainder of the decade are short-lived with an increase to 32% by 1951. Changes to the tax system from 1939 to 1953 were largely enacted through the use of additional war-related income taxes, ranging from an additional 2.5% to 33% added to individuals' final income tax bills. These had the administrative advantage of raising extra revenue without needing to adjust the basic income tax schedule; see Vosslamber (2009).

After WWII the AMTR follows a fairly steady upward trend till 1982, interrupted by two substantial declines: in 1961 and in 1971-3. Both declines largely reflect tax structure, mainly rate, changes but whereas the 1971-3 rate reductions mainly involved declines in top rates (see Figure 2), the 1961 case primarily reflected cuts in lower tax rates and increased exemptions. Both reductions in AMTRs were soon reversed, with exemptions subsequently curtailed in the mid-1960s, and the removal of the general personal exemption plus increased MTRs in 1975 as the early 1970s oil crisis hit. Section 5.3 discusses the decomposition of AMTR changes in more detail.

Figure 5 – AMTRs for New Zealand 1907-2009



**Table 3 – Average marginal tax rates (in percent), 1907-2009**

Year	AMTR (%)	Year	AMTR (%)	Year	AMTR (%)
1907	0.4	1941	21.7	1975	39.3
1908	-	1942	27.3	1976	39.9
1909	-	1943	27.8	1977	38.5
1910	0.4	1944	27.7	1978	43.3
1911	-	1945	30.2	1979	42.1
1912	0.5	1946	25.4	1980	41.7
1913	-	1947	24.4	* 1981	42.6
1914	0.5	1948	26.3	1982	44.6
1915	-	1949	27.1	1983	40.9
1916	-	1950	28.7	1984	35.9
1917	3.0	1951	32.0	1985	37.5
1918	-	1952	29.8	1986	40.4
1919	-	1953	30.1	1987	38.6
1920	4.5	1954	29.5	1988	35.8
1921	-	1955	30.1	1989	33.0
1922	3.7	1956	30.8	1990	29.2
1923	4.6	1957	31.5	1991	29.5
1924	5.1	1958	32.4	1992	29.5
1925	1.9	1959	32.1	1993	29.4
1926	2.2	1960	33.3	1994	29.6
1927	2.8	1961	26.4	1995	29.7
1928	2.6	1962	25.2	1996	29.9
1929	3.1	1963	25.8	1997	28.7
1930	3.3	1964	27.8	1998	28.3
1931	5.5	1965	29.7	1999	27.2
1932	7.2	1966	30.5	2000	26.0
1933	7.4	1967	31.1	2001	27.6
1934	5.8	1968	31.4	2002	28.9
1935	5.5	1969	32.4	2003	29.1
1936	8.0	1970	32.4	2004	29.7
1937	9.6	1971	37.1	2005	30.2
1938	8.7	1972	35.9	2006	30.5
1939	11.3	1973	33.4	2007	30.9
1940	20.5	1974	34.4	2008	31.3
				2009	31.1

\* Data from 1981 are sourced from Inland Revenue

Following the early 1980s peak around 47%, a substantial decline in the AMTR occurs, in part associated with the familiar '80s reforms, though beginning prior to the main mid-1980s reform years, and falling to around 30% by 1990. The data also confirm a decline in the AMTR during 1996-2000 in association with revenue-reducing tax reforms (eg, the lowest MTR<sub>j</sub> fell from 24% in 1994 to 19.5% in 2000, and thresholds were raised). This was followed by a steady rise in the AMTR (from 26% in 2000 to 31% in 2008) following

the increase in the top  $MTR_j$  from 33% to 39% in 2000, and the resulting impact of fiscal drag thereafter as income tax thresholds remained fixed in nominal terms.<sup>16</sup>

Comparing the two series in Figure 5 reveals the impact of our ‘exemptions adjustment’ designed to capture the effect of general exemptions reducing net, relative to gross, income. As noted above, for an (unknown) fraction of taxpayers, this would reduce the statutory marginal tax rate that they faced. It can be seen that the adjustment has little effect on estimated AMTRs except for the early 1940s, 1954-58 and 1961-69. For the first two period AMTRs are reduced by about 1-2 percentage points (ppt); during 1961-69 the *difference* in the series ranged from almost 5 ppt (1962) to 2.4 ppt in 1969. In each of these cases tax structure changes in 1940, 1954 and 1962 involved an increase in the initial income level liable to the 0% marginal tax rate, hence affecting the fraction of taxpayers who may face a lower  $MTR_j$ . *Year-to-year changes* in the two series are however largely unaffected by the adjustments.

Finally, the AMTR calculations described here exclude the impact of ACC levies, the Benefit system and the Family Tax Credit (FTC) system which, at various times since the 1970s, involved lump sum transfers to lower income families with children that were withdrawn at higher income levels at rates of up to 30c/\$, thereby adding to effective  $MTR_j$ s. The effect of FTCs is discussed further below.

## 5.2 Relationships between Exemptions, Non-Filed Incomes and AMTRs

The calculated AMTRs incorporate estimates of the amount of income exempt from tax, including income which was not required to be filed with the tax department, and its impact on the effective marginal tax rate faced by individuals. Non-filer income is effectively treated as being ‘taxed’ at a zero tax rate in our calculations, and this has a significant impact in lowering the AMTRs. For exempt income we have sought to capture the impact of exemptions in moving people to lower marginal tax brackets as discussed above. This had a smaller, but nevertheless noticeable impact, especially where it moves some taxpayers into a tax-free income bracket.

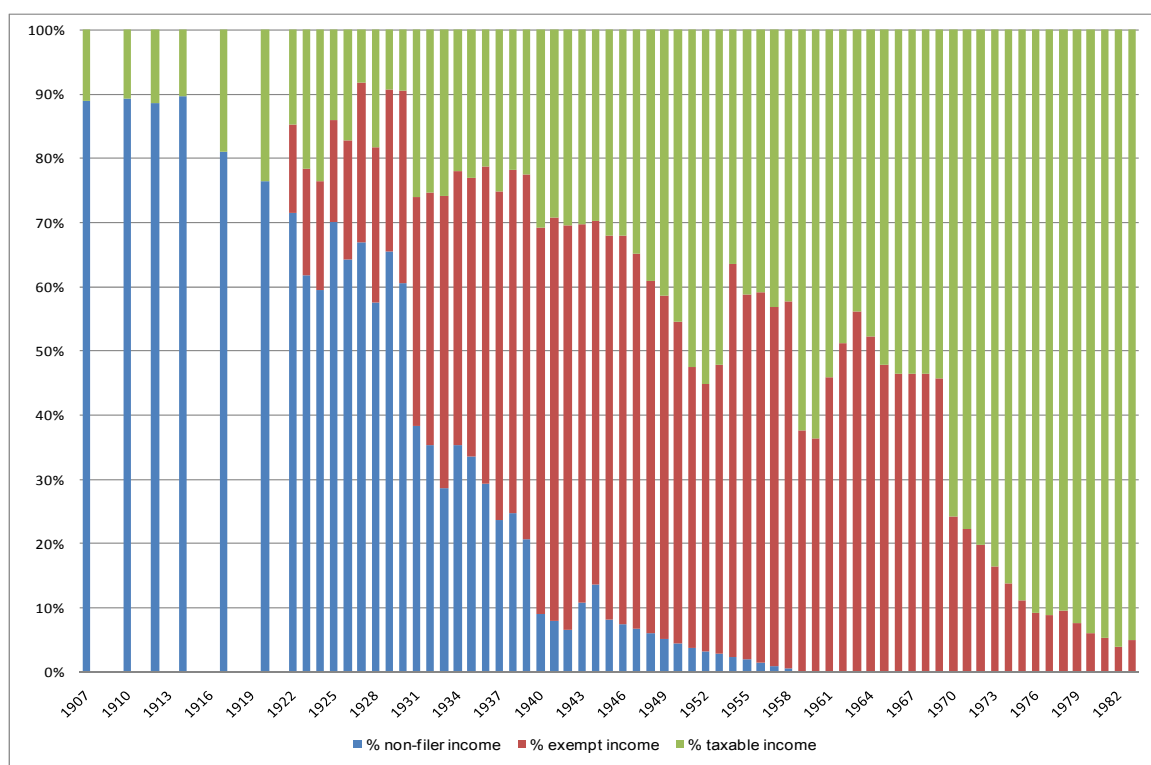
Figure 6 shows how the proportions of exempt and non-filer income changes over the 1907 to 1982 period. (This is not readily calculated for the post-1982 IRD dataset). During the early part of the 20<sup>th</sup> century, we estimate that a large proportion of income was not filed. In 1907, approximately 89% of income was not filed because it fell under the £300 filing limit. This proportion reduced steadily throughout the first half of the century, and by 1958 when the PAYE system was introduced it was close to zero. As described above, there were a number of tax exemptions available. The proportion of income which was exempt from tax is shown in red in Figure 6. By 1980 income exempt from tax represented only around 5% of gross assessable income.

---

<sup>16</sup> There is very little fiscal drag under similar conditions during 1990-1995 due to the very flat nature of the two- $MTR_j$  schedule (at 24% and 33%) and fixed nominal thresholds in those years.



**Figure 6 – Proportions of taxed, exempt and non-filed income, 1907 – 1983**



### 5.3 Decomposing Changes in the AMTRs

The variations in the AMTR over the period can be decomposed into changes to the tax system, changes in average income levels, and changes to the income distribution. The impact of each of these varies across the period. This section attempts to identify the most significant impacts in different time periods.

The AMTRs changed only slightly during the period 1907 – 1916, due to minor changes in both tax rates and income distribution. In 1914 the multi-slope scale was introduced. It did not have a large impact on the AMTR, however, as the tax rates remained low and there were many unaffected non-filers.

In 1917 effective marginal tax rates were increased substantially (by around 3 times at the lower end of the income distribution and up to 8 times at the upper end). The increase included the addition of a ‘special war tax’. In addition, abatement of the general exemption was introduced. As a result the AMTR increased from 0.5% in 1914 to 3.0% in 1917. It increased further to 4.5% in 1920, solely as a result of increasing incomes which moved people into higher tax brackets (the tax system did not change). From 1922 to 1924 tax rates were reduced slightly, but the AMTRs continued to rise due to increasing incomes shifting the distribution towards higher income tax brackets.

It was not until 1925, however, that post-WWI tax rates fell more significantly, with the top marginal tax rate dropping from 29% in 1924 to 22.5% in 1925. Thereafter the AMTR generally rose slowly over the remaining ‘20s and ‘30s, except for a relatively large rise (compared to previously) between 1930 and 1932. This largely reflected tax schedule changes in 1931.<sup>17</sup> In the same year, total income dropped by 5% and the income

<sup>17</sup> For example, the statutory MTRs were approximately doubled across the income distribution and the tax-free threshold was reduced; a 30% additional tax was added to the final tax bill; social security tax was introduced at 1.25%; and a supplementary 33.33% tax was applied to unearned income.

distribution was skewed downwards. The net effect of these changes was an increase in the AMTR from 3.3% in 1930 to 5.5% in 1931.

From the mid-1930s to the early post-WWII years, AMTRs rose rapidly and did so again from the mid-1970s until the early 1980s. In between, the roughly 30 year period from the mid-1940s to mid-1970s reveals a steady upward trend the AMTRs, punctuated by a brief decline from 1951-54 and the sharp fall in 1961-63.

The especially rapid rise in the lead-up to, and during, WWII largely reflects tax system changes: mainly tax rate and threshold changes designed to raise additional revenue. In 1936 tax rates were increased substantially (the top marginal rate on earned income increased from around 43% in 1935 to 65% in 1936), and increased again in 1939 plus an “additional tax” at 15% to finance the war effort (War Expenses Act 1939). In 1942 social security was increased to 12.5% and the additional tax was increased from 15% to 33.3%. Combined with an upward movement in incomes, these changes generated a rise in the AMTR to 27% in 1942 and 30% by 1945.

Unsurprisingly, the sharp drop in the AMTR in 1946 captures the reduction in social security and the additional ‘war’ tax to 10% and 15% respectively in the aftermath of the war. However, as noted above, upward movements from 1948 are interrupted by reductions in 1951-54 and 1961-63. Both appear to arise mainly from legislated increases in exemptions. The large drop in 1962-63 reflects both increased generosity of exemptions (they rose from 46% of total gross assessable income in 1961, to 56% in 1963) and across-the-board upward shifts in MTR<sub>j</sub> thresholds in 1962.

The upward trend in the AMTR was interrupted briefly in the early-1970s and halted sharply in 1982 – well before the major economic and tax reforms of the mid-1980s. As with the AMTR declines in 1962-63, the decline in AMTR from 1982-84 is associated with increases in the tax thresholds at most income levels (but a new higher top rate) and some schedule simplification in 1984. The major reforms involving a reduced top rate did not become effective until 1988-89 when the top MTR<sub>j</sub> was reduced from 66% in 1987 to 48% in 1988 and 33% in 1989.

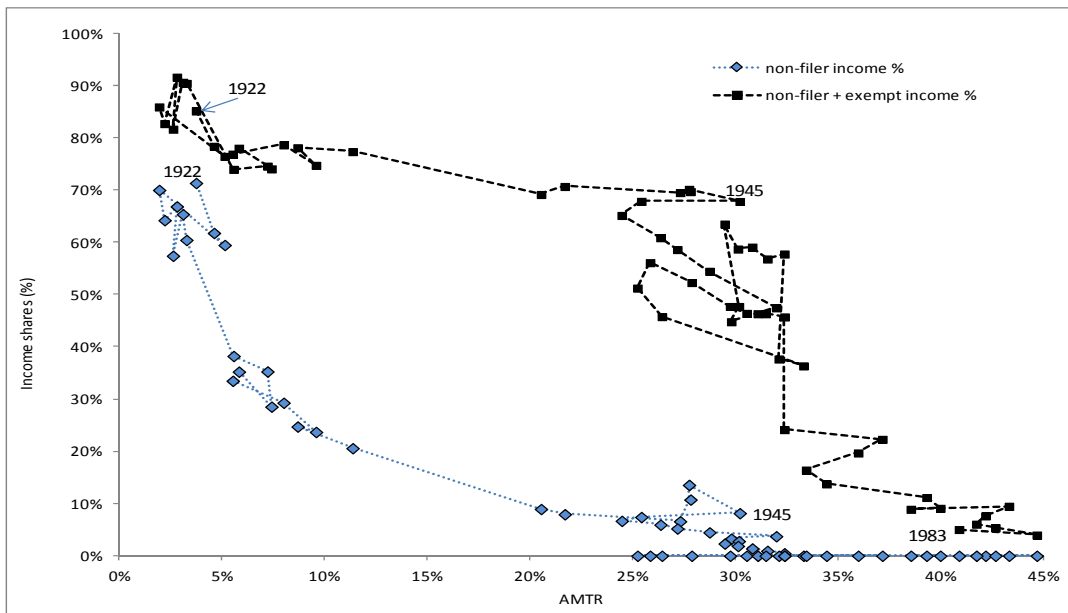
Further insight into the time-series pattern of AMTRs, and the role of different components, can be obtained by considering the relationship between personal income *not* subject to income tax and the AMTR. Figure 7 shows cross-plots of the AMTR with the estimated income share of non-filers. It also shows the share of income (of filers) that is tax-exempt – where the latter is added to the former in Figure 7. Increasing exemptions push more taxpayers into tax-free status (when an initial zero tax rate exists) as well as reducing positive MTR<sub>j</sub>s for others.

The Figure shows the time-series from 1922 (top left corner) to 1983 (bottom right corner) with dashed lines joining annual observations.<sup>18</sup> The non-filers’ share reaches zero (in 1958) and therefore tracks the horizontal axis thereafter. The non-filers’ income share reveals a clear negatively-sloped, and non-linear, relationship with the AMTR, - the correlation with the AMTR is -0.91 (1922-58). The relationship of the AMTR to exemptions is more complex. Though the *combined* ‘non-filers plus exemptions’ share in Figure 8 reveals a negative slope, for exemptions alone the correlation with the AMTR is +0.76 (1922-58) but -0.93 (1959-83). That is, as AMTRs generally rose over time, and non-filing became less common (to 1958), exemptions tended to replace non-filing as the preferred means of keeping tax rates low or zero on lower income earners. After 1958 however, when PAYE was introduced, exemptions tend to decline over time in association with rising AMTRs.

---

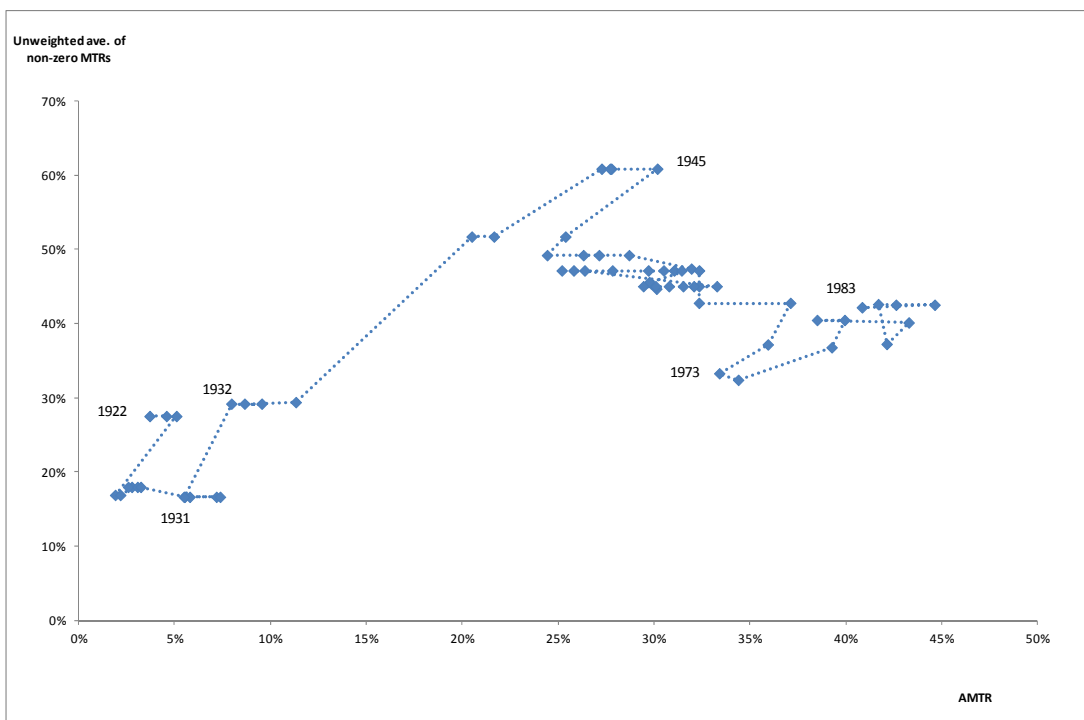
<sup>18</sup> 1983 is the last year for which we can conduct this exercise due to the switch to IRD unit record data thereafter.

**Figure 7 – AMTRs and tax exempt/non-filed income, 1922-1983**



Of course, in any given year the share of income that is exempt from tax depends on a variety of underlying factors including income growth, tax schedule changes and so on. With some years involving tax schedules with many different MTR<sub>s</sub> and thresholds, a formal decomposition into income changes and tax system changes cannot readily be made. However, it is useful to consider year-to-year changes to all *non-zero* MTR<sub>s</sub> in the tax schedule since this provides one indicator of changes in the tax structure other than exemptions. We take a simple unweighted mean of all non-zero tax rates in the personal income tax schedule for each year – using effective marginal rates rather than statutory rates.<sup>19</sup> These are plotted against the AMTR for 1922-83 in Figure 8.

**Figure 8 – Cross-plot of AMTR and non-zero EMTR<sub>i</sub> average, 1922-1983**



<sup>19</sup> That is, social security, additional taxes/discounts and exemption adjustments are included. Using statutory rates yields similar results.

This reveals that the rise in the AMTR occurred largely in association with a rise in the ‘average’ non-zero MTR<sub>j</sub> that each individual faced in the tax schedule from around 1931 (bottom left corner), until around 1942-45 but not thereafter. That is, for the post-WWII period, increases in the AMTR are not generally associated with changes to the tax schedule that raised MTR<sub>j</sub>s, though this does not of course preclude changes in thresholds that meant a given MTR<sub>j</sub> applied at higher or lower income levels. In essence, by the 1940s, top (and other) MTRs had reached sufficiently high levels, that they tended to remain around those levels or fall back in subsequent years.

Though these broad patterns over several years are revealing they do not indicate the extent to which each annual change in the AMTR reflects its various components. To apply that here, for the 1907-2009 period, first consider a simplified two-rate step function involving two tax rates,  $t_0, t_1$ , where  $t_0 = 0$ , and  $t_1 > 0$ . For this simplified case the change in the AMTR,  $dM$ , can be broken down into:

$$dM = w_1 dt_1 + t_1 dw_1 + dt_1 dw_1 + \{ w_0 dt_0 + t_0 dw_0 \} \quad (8)$$

where  $w_1$  is the income weight of taxpayers facing  $t_1$  ( $= 1 - w_0$ ), and the term in curly brackets is zero ( $t_0 = dt_0 = 0$ ). The income weights are affected by tax thresholds that determine the MTR<sub>j</sub>s applicable at different taxpayer income levels. Of course the NZ personal income tax schedule involves a more complex structure of several (sometimes many!) non-zero tax rates. Nevertheless it is useful to approximate the exact specification in (8) using the annual ‘unweighted average’ of the *non-zero* MTR<sub>j</sub>s, in the schedule, as shown in Figure 8. Thus (8) becomes:

$$dM = w'_1 dt'_1 + t'_1 dw'_1 + dt'_1 dw'_1 + R \quad (8')$$

where  $t'$  is the simple average of non-zero MTR<sub>j</sub>s in the schedule,  $w'$  is the income weight of all taxpayers facing a non-zero MTR<sub>j</sub>, and  $R$  is a residual – capturing the omitted components involving changes in each non-zero MTRs relative to the average  $t'_1$ , changes in associated tax thresholds, and changes in income shares relative to  $w'_1$ .

Using (8') to decompose changes in AMTRs ( $dM$ ) for each year during 1907-83 gives the following correlation matrix where pre- and post-1940 correlations are examined separately – Figure 9 suggests a different relationship after around 1940.

**Table 4 – Correlation matrix of AMTR changes**

	1907-40			1941-83		
	$w'_1 dt'_1$	$t'_1 dw'_1$	$dt'_1 dw'_1$	$w'_1 dt'_1$	$t'_1 dw'_1$	$dt'_1 dw'_1$
$t'_1 dw'_1$	<b>0.19</b>	-	-	-0.15	-	-
AMTR	<b>0.85</b>	<b>0.24</b>	<b>0.51</b>	0.34	0.08	0.27

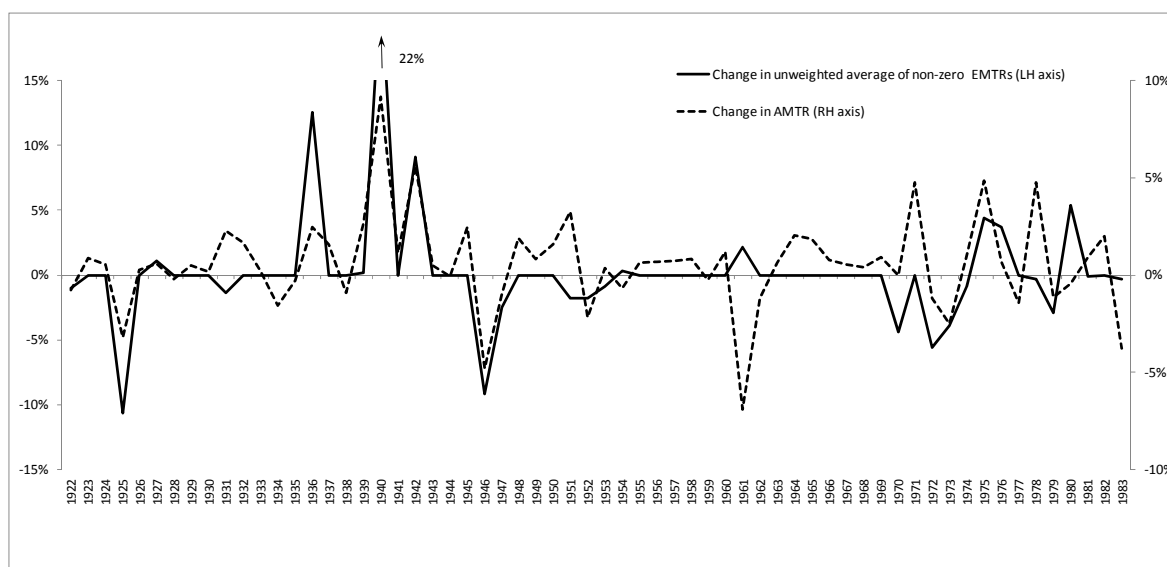
It can be seen that both changes in the share of taxable in total income,  $t'_1 dw'_1$ , and changes in ‘average’ non-zero MTR<sub>j</sub>s,  $w'_1 dt'_1$ , are positively correlated with annual changes in the AMTR. However changes in the taxable income share have a much smaller correlation at 0.24 versus 0.85 (pre-1940) and 0.08 versus 0.34 (post-1940). The positive cross-correlation between,  $w'_1 dt'_1$  and  $t'_1 dw'_1$  reveals that this has a larger effect on the AMTR than the change in the income weight,  $t'_1 dw'_1$ .

These correlations therefore reinforce the view that, at least to around 1940, the annual AMTR changes were largely associated with changes in the set of non-zero EMTR<sub>j</sub>s – both directly and via the associated change in income weights (due to  $dt'_1 dw'_1$ ). By themselves change in the income weighting (between taxed and untaxed incomes) within the AMTR calculation had relatively little impact. After 1940 changes in average non-zero

tax rates are still important but other factors (hidden within the residual in equation (8')) appear to be more important.

The data underlying these correlations can be seen in Figure 9, which plots the annual change in the AMTR (right-hand axis) and the unweighted average non-zero EMTR<sub>s</sub> (left-hand axis). This reveals that for many years the EMTR<sub>s</sub> remain relatively constant (generally because statutory rates are unchanged), while the AMTR changes - because of changes to income levels/distribution, changes in thresholds, exemptions etc. Nevertheless, many of the largest changes in the AMTR are associated with substantial changes in statutory or effective marginal tax rates such as in 1925, 1936, 1940-42, 1946 and the 1970s.

**Figure 9 – Changes in unweighted averages of EMTR<sub>s</sub> and AMTRs, 1922-1983**



## 5.4 Earned vs. Unearned Income

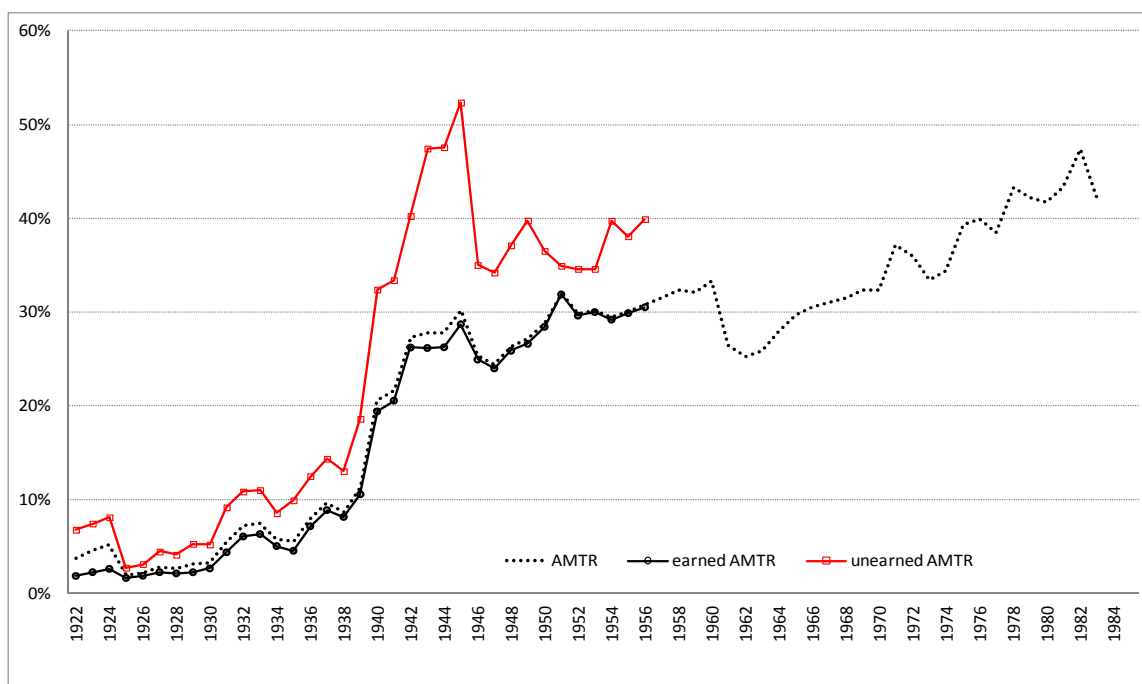
As noted above, throughout the period from 1922 to 1949 a distinction was made between earned and unearned income and these were taxed at different rates. Figure 10 shows the AMTRs for earned and unearned income, as well as the total AMTR. Up until 1930 the tax rate on earned income was reduced by 10% (relative to that for unearned income) for the first £2000 of income. During this period the AMTRs for the two types of income tracked each other fairly closely, with the AMTR for unearned income generally at 2% to 5% above that on earned income.

From 1931 to 1949 the distinction was changed such that the tax on unearned income was increased by 33.3% relative to that on earned income. From 1939 the gap between the unearned AMTR and earned AMTR begins to increase, reaching its greatest divergence in 1945 with a gap of 24 percentage points. This widening gap is due exclusively to the changing relative income distributions of earned and unearned income. The proportion of unearned income at the top end of the income distribution increased dramatically during this period. For example, the proportion of unearned income in the top bracket (>£4000) increased from 2% in 1940 to 17% in 1945, while the proportion of earned income in this top bracket remained fairly constant at around 1%.

Unsurprisingly, the overall AMTR is driven mostly by the AMTR for earned income reflecting the low share of unearned income in total income. Moreover, this proportion decreased substantially over the period, such that the very large AMTRs for unearned income in the mid 1940s did not have such a large impact on the overall figure. Unearned income made up around 40% of all filers' income in the early 1920s, but had dropped to

around 4% by 1949, the last year in which the two were taxed at different rates. Indeed the drop in (declared) unearned income in the 1940s may in part reflect responses to the very high marginal tax rates applied to it.

**Figure 10 – AMTRs for earned and unearned income, 1922-1956**



From 1950-56 the earned/unearned distinction was no longer relevant for tax purposes, but Statistics New Zealand continued to collect the data separately. For this period the difference between the two AMTRs – of the order of 5 to 6% - solely reflects the different income distribution of earned and unearned income.

## 5.5 The Effect of Family Tax Credits, Benefits and ACC

Family tax credits (FTC) and various other social welfare benefits have operated via the tax system in New Zealand since at least the 1970s. These have often involved the withdrawal of transfers/benefits in association with increases in individual or family income levels, thereby affecting EMTRs of the income tax-transfer system as a whole.<sup>20</sup> Systematically incorporating these withdrawal/abatement effects in our AMTR calculations is beyond the scope of our analysis. Indeed it is hard to find suitable descriptions of the system, and relevant data, on an annual basis that would allow us to include its AMTR impact.

**Table 5 – EMTRs for family tax credits, welfare benefits and ACC**

WFF & Benefit		ACC	
EMTRs	Income share	EMTRs	Income share
0%	90.6%	0%	16.6%
20%	8.3%	1.3%	83.4%
30%	0.07%		
70%+	1.03%		
AMTRs: 1.7% (WFF) 0.7% (Benefits)		1.1% (ACC)	

<sup>20</sup> For a description of the system as it operated up to 1999, see Leibschutz (1999).

However, for 2008, Inland Revenue has examined the effect on individual taxpayers' EMTR<sub>j</sub>s, and the aggregate AMTR, of the combined FTC, Benefit and ACC (Accident Compensation Corporation) systems. Calculating the income-weighted AMTR for income taxes, FTC, ACC and Benefits combined yields an AMTR of 34.7% compared to 31.3% for income tax only. That is, at the aggregate level the impact of the FTC, welfare benefits and ACC on the AMTR is around 3 percentage points. Table 5 reports the EMTR<sub>j</sub>s for the three components and a decomposition of the combined AMTR.

The table shows EMTR<sub>j</sub>s for FTC and benefits of 0%, 20%, 30%, and 70% and above, with taxpayers facing 0% accounting for the lion's share of total income but with around 8% of taxpayers by income-share facing 20% EMTR<sub>j</sub>s (in addition to their income tax MTR<sub>j</sub>). For ACC, most taxpayers (who account for over 80% of total income) faced the 1.3% levy in 2008. The final row of Table 5 shows the contributions to the AMTR, with FTC adding the largest element to the overall AMTR (1.7%) with a combined 3.4 percentage points added to the AMTR for income taxes.

## 5.6 Reliability of AMTR Estimates

It is clear that, with different qualities of data collection likely throughout the 100 year period that we are considering, together with differences in the suitability of available data for our purposes and our methodologies to analyse them, the reliability of our AMTR estimates is also likely to be variable. In general we might expect the reliability of the estimates to improve over time. In particular the post 1981 data, being based on Inland Revenue unit record data might be expected to be more accurate. Encouragingly, when we estimate the three overlap years, 1981-83, using the more aggregative data and methods applied in the pre-1981 period, there is a reasonably close match with the IRD estimates. This suggests that, at least in the years leading up to 1981, calculation of AMTRs from aggregate-level income information is relatively accurate. Similarly, as noted earlier, the effect of adjusting the AMTRs using total exemptions data, the accuracy of which is unknown, would appear in general to have little impact on year-to-year changes in the AMTR. Nevertheless, the omission of a range of social welfare transfer payments from our EMTR<sub>j</sub> and AMTR calculations is likely to be especially important from the 1970s onwards when such income-related payments became more prevalent.

For pre-1922 years we have chosen not to extrapolate back to 1892 or interpolate between years of available data because we have no reliable income information on which to base them (though we do know the tax schedule). Subsequently, the main source of inaccuracy in our annual estimates may be the need to use less frequent census and other data to estimate annual non-filer income shares during the period to 1951; see Appendix 4. These involve a number of simplifying assumptions and rely on indirect methods to identify incomes for those who are not recorded in any contemporary income database. Further, the introduction in 1959 of the PAYE tax administration system probably improved the quality of central recording of taxpayer incomes in aggregate and may therefore impact on the reliability of our AMTR estimates. More generally, we have no alternative data to apply as a cross-check on the method we use to incorporate the impact of tax-exempt income on EMTR<sub>j</sub>s; namely using the ratio of exemptions to gross income as shown in equation (7). However, the impact of this adjustment is generally small on the EMTR<sub>j</sub> estimates compared to those without this adjustment.

## 6 Conclusions

---

Following the methods proposed by Barro and Sahasakul (1983, 1986) to calculate an ‘aggregate’ marginal income tax rate (AMTR), which they applied to US data, this paper has adapted the methodology to derive a similar aggregate tax rate measure for New Zealand. This involved 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. These calculated rates largely avoid the endogeneity problems of more commonly used aggregate-level MTRs based on tax revenue data.

We have constructed the AMTR measure for 1907-2009. Our approach to constructing an income-weighted AMTRs was 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 combined 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 enabled 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 reveals that rates 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 generally rises 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.



## References

---

- Angelopoulos, K., Economides, G and Kammas, P. (2007) Tax-spending policies and economic growth: theoretical predictions and evidence from the OECD. *European Journal of Political Economy*, 23, 885-902.
- Arnold, J., Brys, B., Heady, C., Johansson, Å., Schwellnus, C. and Vartia, L. (2011) Tax policy for economic recovery and growth. *Economic Journal*, 121, February, 2011, F59–F80.
- Barro, R.J. and Sahasakul, C. (1983) Measuring the average marginal income tax rate from the individual income tax. *Journal of Business*, 56, 419-452.
- Barro, R.J. and Sahasakul C. (1986). “Average Marginal Tax Rates from Social Security and the Individual Income Tax,” *Journal of Business*, 59, 555-566.
- Barro, R.J. and Redlick, C.J (2011) Macroeconomic effects from government purchases and taxes, *Quarterly Journal of Economics*, 126, February, 51-102.
- Beetsma, R. and Giuliodori, M. (2011) The effects of government purchases shocks: review and estimates for the EU, *Economic Journal*, 121, February, 2011, F4–F32.
- Easton, B.H. (1983) Income Distribution in New Zealand, NZIER Research Paper No 28, Wellington.
- Gemmell, N., Kneller, R. and Sanz, I. (2011a) The timing and persistence of fiscal policy impacts on growth: evidence from OECD countries. *Economic Journal*, 121, February, 2011, F33–F58.
- Gemmell, N., Kneller, R. and Sanz, I. (2011b) The growth effects of corporate and personal tax rates in the OECD. Bond University Globalization and Development Centre, Working Paper No 49 (May).
- Goldsmith, P. (2008) *We Won, You Lost. Eat That! A Political History of Tax in New Zealand Since 1840*. Auckland: David Ling Publishing Limited.
- Lee, Y. and Gordon, R.H. (2005) Tax structure and economic growth, *Journal of Public Economics*, 89, 1027-1043.
- Leibschutz, D.S. (1999) *Taxes and Poverty in New Zealand The Impact of the Tax and Benefit System on Low-Income New Zealanders*. Ian Axford Fellowships Office, 1999. Available at [www.fulbright.org.nz/voices/axford/docs/leibschutzd.pdf](http://www.fulbright.org.nz/voices/axford/docs/leibschutzd.pdf). (Accessed on 15-06-2011).
- Myles, G.D. (2009a) *Economic Growth and the Role of Taxation – Theory*. OECD Economics Department Working Papers, No. 713, OECD Publishing.
- Myles, G.D. (2009b) *Economic Growth and the Role of Taxation – Aggregate Data*. OECD Economics Department Working Papers, No. 714, OECD Publishing.
- Ramey, V.A. (2009) Defense News Shocks, 1939-2008: Estimates Based on News Sources.” unpublished, University of California San Diego, October.
- Ramey, V.A. (2011) Identifying Government Spending Shocks: It’s All in the Timing. *Quarterly Journal of Economics*, 126, February, 1-50.
- Rankin, K. (1995) Unemployment in New Zealand at the peak of the Great Depression. University of Auckland Working Papers in Economics, No. 144, Auckland: University of Auckland.

Romer, C.D. and Romer, D.H. (2010) The macroeconomic effects of tax changes: estimates based on a new measure of fiscal shocks, *American Economic Review*, 100, 763-801.

Romero-Avila, D. and Strauch, R. (2008) Public finances and long-term growth in Europe: evidence from a panel data analysis, *European Journal of Political Economy*, 24, 172-191.

Vosslamber, R. (2009) How Much? Taxation on New Zealanders' Employment Income 1893-1984, *New Zealand Journal of Taxation Law and Policy*, 15, 299-321.

## Data Sources

---

Census and Statistics Department, *Population Census – 1926, 1931, 1936, 1945, 1951*.

New Zealand Taxation Review Committee (1967) *Taxation in New Zealand: Report of the Taxation Review Committee*, ("Ross Report"), October 1967.

Brookers Tax Service, *Staples and Tax Rates Guide*, available at: <http://www.brookersonline.co.nz/databases/modus/taxsvc/tcstrg/GEN-SCOPE!174?tid=6990887&si=1610670095> (last accessed 12/06/11).

Statistics New Zealand (formerly Department of Statistics), *New Zealand Official Yearbooks*, (various years, 1892-1983).

Statistics New Zealand, Long-term Data Series, available at: [http://www.stats.govt.nz/browse\\_for\\_stats/economic\\_indicators/NationalAccounts/long-term-data-series/labour-market.aspx](http://www.stats.govt.nz/browse_for_stats/economic_indicators/NationalAccounts/long-term-data-series/labour-market.aspx)

Statistics New Zealand, *Report of Incomes and Income Tax* (various years, 1972-1984).

# 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  $\tau^*$  be the marginal tax rate specified in the tax schedule as levied on assessable income, so that the total tax paid is:

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

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

$$\tau = dT/dy = \tau^* + (y - a)(d\tau^*/dy) \quad (A2)$$

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  $\tau^*$  increases by 3/400ths of a penny for each pound increase in income. Hence:

For  $400 < y \leq 1400$ :

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

$$\Rightarrow \tau^* = 0.0125 + 0.00003125y \quad (A3)$$

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

$$\tau = 0.003125 + 0.0000625y \quad (A4)$$

giving  $\tau = 0.028125$  at  $y=400$  and  $\tau = 0.090625$  at  $y=1400$ . Values of  $\tau$  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  $\tau^*$  ( $1/(400*240)$ ) yields:

$$\tau^* = 0.04168 + 0.000010417y \quad (A5)$$

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:

$$\tau = 0.038552 + 0.000020834y \quad (A6)$$

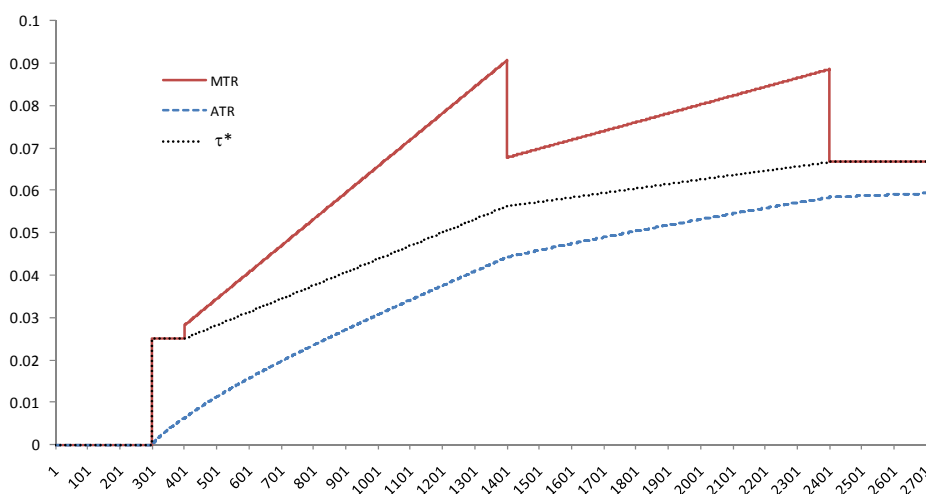
Equation (6) yields:  $\tau = 0.06772$  at  $y=1400$  and  $\tau = 0.08855$  at  $y=2400$ . Values of  $\tau$  for  $y$  between 1400 and 2400 are on a straight line between these two points. Beyond 2400, the marginal tax rate is specified as a constant 14 pennies per pound, or 5.83%.

This reveals that the EMTR can be higher, and sometimes considerably higher, than  $\tau^*$  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:

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

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

$$\left. \begin{aligned} \tau &= \tau^* + (y - a)(d\tau^*/dy) & y \leq 600 & & \text{where } d(y - a)/dy = 1 \\ \tau &= 2\tau^* + (y - a)(d\tau^*/dy) & 600 < y \leq 900 & & \text{where } d(y - a)/dy = 2 \\ \tau &= \tau^* + y(d\tau^*/dy) & y > 900 & & \text{where } a = 0; d(y - a)/dy = 1 \end{aligned} \right\} (A8)$$

For  $300 \leq y \leq 400$ , 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:

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

For  $400 \leq y \leq 600$ , 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:

$$\tau^* = 0.041667 + 0.000052083y \quad (A9)$$

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  $\tau^*$  yields:

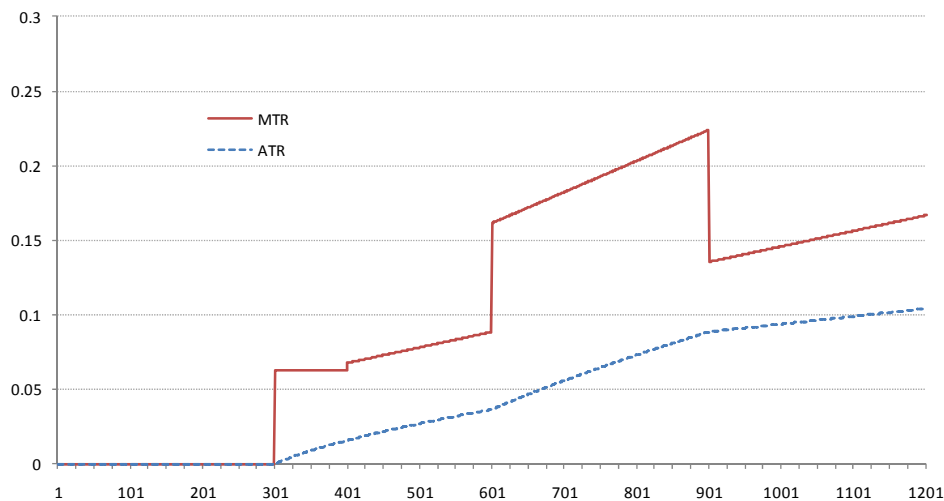
$$\tau = 0.03646 + 0.00020833Y \tag{A10}$$

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

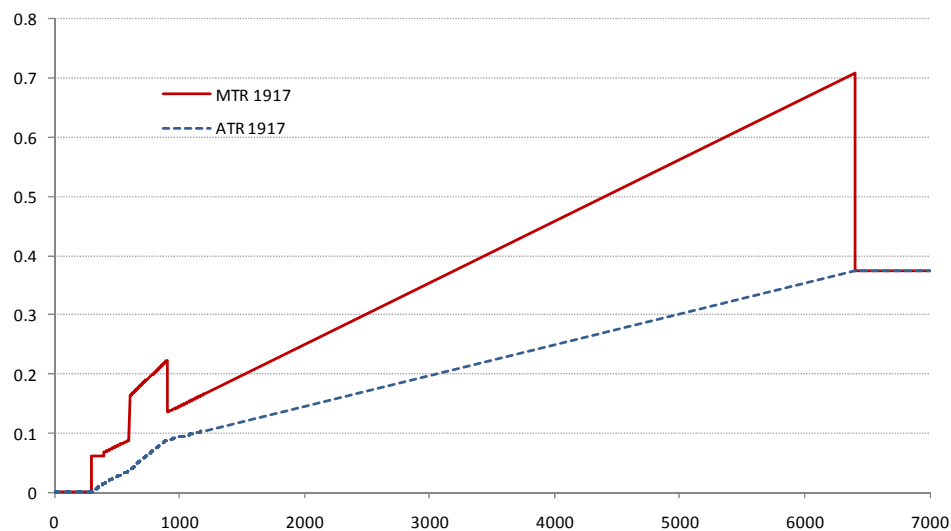
For  $900 \leq y \leq 6,400$ ,  $\tau^*$  is given by the last line of (A8) such that, with no exemptions,  $\tau = 0.1354$  at  $y = 900$  and  $\tau = 0.7083$  at  $y = 6,400$ . Thereafter, for incomes in excess of 6400 there is no longer any increase in  $\tau^*$  as incomes increase, That is,  $d\tau^*/dy = 0$  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 20<sup>th</sup> 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 20<sup>th</sup> 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

data would capture a larger number of individuals who formerly were not captured. However, a large increase in assessable income of low income taxpayers, that might have been expected, did not eventuate; it may be that the depression pushed many below the £200 income level. From 1935 the recorded income of low income taxpayers did start to rise significantly.<sup>21</sup>

### **1942 – 1945 (Source: Estimated)**

Data are not available - the NZOYB was not compiled because of labour shortages in WWII. We have again applied linear interpolation of income shares to estimate the missing years.

### **1946 – 1960 (Source: NZ Official Yearbooks)**

Individual taxpayer data are available through this period. From 1949 the compilation of statistics was changed from a population of income assessments to a 10% sample, but a full enumeration of assessments for incomes above £2,500. Certain types of non-assessable (and hence non-taxable) income, such as war pensions and social security benefits, were not captured in the NZOYB income data. All individuals whose income exceeded £200 were required to file a tax return. Our estimates of non-filer income suggests that by the early 1950s only a small proportion of total taxable income was not being captured by income filed with Inland Revenue; the introduction of Pay-As-You-Earn (PAYE) source-based taxation in 1958 rendered the filer/non-filer distinction redundant for our purposes.<sup>22</sup>

### **1961 – 1984 (Source: NZ Official Yearbooks to 1971; Report of Incomes and Income Tax, 1972-84)**

Previously discussed income data are available throughout this period (except data for 1962 were never published - we have again applied linear interpolation). Also, in 1967 New Zealand implemented a decimal (Dollar) currency system (set at \$2 = £1), but income data presented in decimal form are available in the NZOYB from 1962.<sup>23</sup>

---

<sup>21</sup> From 1938, individual and company tax data are presented in separate subsections within the NZOYB. As a result, any indirect capture of company income in previous data (for instance through exemptions) is eliminated, though this is not expected to be significant.

<sup>22</sup> The PAYE system, introduced on 1 April 1958, led to a disruption in the collection of 1958 income year data. Taxpayers solely earning salary and wage income did not have to furnish a tax return for income under £1,040. As a result, income data for the 1958 income year may under represent low income earners.

<sup>23</sup> The *Report on Income and Income Tax* was not produced for the 1975 and 1977 years. For those years we have used provisional income tax data (salary and wage, self-employed persons and investment income) available from the NZOYBs.

## Appendix 3: Exemptions Data

---

Exemptions of certain income from tax were an important feature of the New Zealand personal income tax system up until the 1970s. A portion of income was exempt from tax for a specified set of circumstances. These included:<sup>24</sup>

- *General personal exemption:* The first New Zealand income tax exempted the first £300 of income. The level of the general exemption subsequently varied between £200 and £468.
- *Dependent wife/husband exemption:* Introduced in 1933, the dependent spouse exemption ranged from £50 in 1933-45 to a maximum of £200 in 1960. The exemption was abated against both spouses' incomes, and was in place until at least 1967.
- *Child/dependent exemption:* Allowances for dependent children were first introduced into the Land and Income Assessment Amendment Act 1913. An exemption of £25 for each child under 16 applied, subject to a household income limit of £425. The rate was increased to £50 per child and the age limit increased to 18 from 1922.
- *Housekeeper exemption:* From 1933 an exemption applied to widows and widowers (later divorcees and unmarried people) with dependent children. The exemption ranged from a maximum of £50 to a maximum of £200.
- *Life insurance exemption:* An exemption was given on life insurance premiums in the Land and Income Assessment Act 1891. Premiums were tax deductible up to £50. Contributions to National Provident Fund, superannuation and insurance funds were also tax deductible.

The general exemption was the most significant exemption. Initially, the exemption applied to all taxpayers, but from 1917 until 1935 it abated such that it only applied to incomes below a certain level. From 1936 it applied to all income earners again. Other exemptions were also dependent on income and were abated as income increased. However, we have only been able to account for the impact that abatement of the general exemption had on EMTR<sub>s</sub>. Table A1 below sets out the abatement regimes which applied from 1917 to 1935.

From the early-mid 1920s, NZOYBs provide data on the total value of exemptions claimed by size of assessable income, by exemption category, captured via income tax returns filed with Inland Revenue. In the 1920s, exemption data were presented as an aggregate across all classes of taxpayer, but in general exemptions only applied to the incomes of Class I taxpayers (individuals). An exception was an exemption of 5% on the capital value of unimproved value of land from which income was derived, and which also applied to certain registered companies.

---

<sup>24</sup> At various times during the sample period, other forms of income, were entirely exempt from tax such as war pensions or social welfare benefits. Because those forms of income were non-assessable they are not captured in our tax-return based data, and are therefore not included in our exemption adjustments for the AMTR calculations.



**Table A1 – Abatement of general exemption, 1917-1935**

<b>Period</b>	<b>Abatement regime</b>
1917 – 26	y ≤ £600: £300 exemption £600 < y < £900: exemption withdrawn at £1 per £1 over £600 y ≥ £900: no exemption
1927 – 30	y ≤ £450: £300 exemption £450 < y < £750: exemption withdrawn at £1 per £2 over £450 £750 < y < £900: £150 exemption, reduced by £1 per £1 over £750 y ≥ £900: no exemption
1931 – 32	y ≤ £260: £260 exemption £261 < y < £560: exemption withdrawn at £1 per £3 over £260 £560 < y < £800: exemption of £160, reduced by £1 per £1 10s. over £560 Y ≥ £800: no exemption
1933 - 35	As above with £50 deducted from the exemption ascertained

Table A2 shows the common form of aggregate exemption data presented in the NZOYB for the 1925/26 income year. It shows that the general exemption made up the majority of exemptions and was predominantly received by low income earners (since the exemption was abated with income). With the exception of land value exemptions, other exemptions also appear to be claimed mainly be those with incomes below £1000.

**Table A2 – Exemptions by size of income for the 1925/26 income year**

Size of Income (£)	Total Exemptions (£)			
	5% of Capital Value	Section 74 (300 Pound)	Life Insurance &c	Children &c
Under 300	45,133	3,989,872	563	293
300- 399	83,206	6,856,449	499,928	125,113
400- 499	97,739	3,760,567	636,448	142,353
500- 599	100,794	2,097,296	410,484	114,778
600- 699	102,758	1,169,087	252,207	83,734
700- 799	98,422	453,408	160,940	60,540
800- 899	80,456	129,274	117,923	48,190
900- 999	78,975	23,474	71,816	36,233
1,000- 1,999	574,150	117,944	266,026	126,411
2,000- 2,999	263,633	48,056	54,784	52,927
3,000- 3,999	164,674	27,925	14,882	16,713
4,000- 4,999	126,585	12,714	8,345	11,416
5,000- 5,999	78,401	3,396	3,450	5,169
6,000- 6,999	67,920	2,578	2,050	2,537
7,000- 7,999	62,854	1,319	950	1,010
8,000- 8,999	52,007	8,110	1,000	1,961
9,000- 9,999	42,971		350	446
10,000-19,999	176,275	4,447	600	1,155
20,000-29,999	108,907		250	13
30,000-39,999	82,690			
40,000-49,999	65,919			
50,000-99,999	99,822			
100000 and Over	63,417			
<b>Totals</b>	<b>2,717,718</b>	<b>18,706,016</b>	<b>2,502,996</b>	<b>831,082</b>

Data presented in the NZOYB are 'effective exemptions'. That is, where the exemption amount exceeded assessable income, the allowable exemptions were reduced accordingly. From 1935 the distribution of exemptions by size of income were presented as an average per £100 and from 1948 exemptions distribution data are again presented as total exemptions claimed rather than as averages.

## Appendix 4: Estimating Non-filers' Incomes

An important issue in the measurement of AMTRs is the inability of tax-return-based data in the NZOYBs to capture the incomes of those not required to furnish tax returns – expected to be significant for low income earners during the early part of the 20<sup>th</sup> century. This Appendix briefly outlines how we quantify the size of income of non filers not adequately captured by NZOYB data. This provides suitable income weights to attach to those income earners who effectively face a zero personal income tax rate.

The approach used to estimate non-filer income follows three stages.

### 1. Estimate the number of potential non-filers

The total number of employees, from the long term data file at the Statistics New Zealand's (SNZ) website,<sup>25</sup> was used as a proxy for the total number of individual income earners. The number of individual taxpayers from the NZOYB was subtracted from total employees to produce an estimate of the total number of non filers.

### 2. Estimate the average annual income of non-filers

A distribution of the population by income, from NZ censuses, was used to estimate the average annual income level of non filers – which are predominantly low income earners. The 1926 census was the first to include a question on incomes, and we were able to source a count of the population by income from that census onwards. Through the first half of the 20<sup>th</sup> century in New Zealand, income tax returns were not required to be completed for those earning under a certain income (£300 in 1926). Fortunately, census data on income over this period focused on ranges of income that were close to this low income exemption. For instance, the 1926 census asked respondents to indicate their annual income from the following ranges.

No income	< £52	£52 - £155	£156 - £207	£208 - £311	£312 - £363	> £363
-----------	-------	------------	-------------	-------------	-------------	--------

Aggregate tables by income and age were obtained for the 1926, 1936, 1945 and 1951 censuses. From the aggregate tables, we ignored those under the age of 16 and those who indicated they did not earn any income ie, we aimed to count only those most likely to be making work and investment decisions. Furthermore, for the purpose of estimating the average income of non-filers, people earning over the low income exemption were also excluded in our calculation. The weighted average income of non-filers was estimated by multiplying the mid-point of each income bracket (deemed to include non-filers) by the corresponding weight each selected bracket contributed to the total of the selected population. Table A3 presents our estimated average income of non-filers from the 1926 census and the corresponding weights used to derive it.

**Table A3 – Estimated average income of non-filers from 1926 census data**

Income bracket	Under £52	£52 to £155	£156 to £207	£208 to £311
Weight of selected population by income bracket	11.3%	38.3%	20.1%	30.2%
Midpoint	£26.00	£103.50	£181.50	£259.50
Weighted average income	£158			

<sup>25</sup> Long-term labour market statistics can be found here: [http://www.stats.govt.nz/browse\\_for\\_stats/economic\\_indicators/NationalAccounts/long-term-data-series/labour-market.aspx](http://www.stats.govt.nz/browse_for_stats/economic_indicators/NationalAccounts/long-term-data-series/labour-market.aspx)

### 3. Calculate total income of non-filers

The estimated average income above was multiplied by the estimated number of non-filers, giving total income generated by non-filers. This total income can then be used to increase the weight associated with the lowest income group's contribution to the AMTR calculation. However, as noted in the NZOYB, some low-income earners, despite not being required to file a tax return, still furnished returns and were captured in the NZOYB income data. As a result, the income recorded in the NZOYB under the lowest income bracket was subtracted from our estimated total non-filer assessable income to avoid any double counting.

Table A4 outlines the process of calculating total assessable income of non-filers. Unsurprisingly, the estimated number of non-filers, and in turn income, was considerable in 1926. As income rose over time in general, a smaller number of taxpayers fell into the non-filer group leading to a lower amount of non-filer income.

**Table A4 – Estimated non-filer income**

Income year	Tax payers	Number employed	Estimated non filers	Estimated average income of non filers	Estimated total income of non filers	Assessable income within non filer income bracket	Additional income for AMTR calculation
	(A)	(B)	(C)=(B)-(A)	(D)	(E)=(C)×(D)	(F)	(G)=(E)-(F)
1926	43,910	563,718	519,808	£158	£81,931,267	£4,162,525	£77,768,742
1936	80,530	587,712	507,182	£84	£42,818,313	£20,118,237	£22,700,076
1945	310,926	628,471	317,545	£101	£31,945,578	£25,217,000	£6,728,578
1951	452,890	730,868	277,978	£96	£26,632,198	£15,790,000	£10,842,198

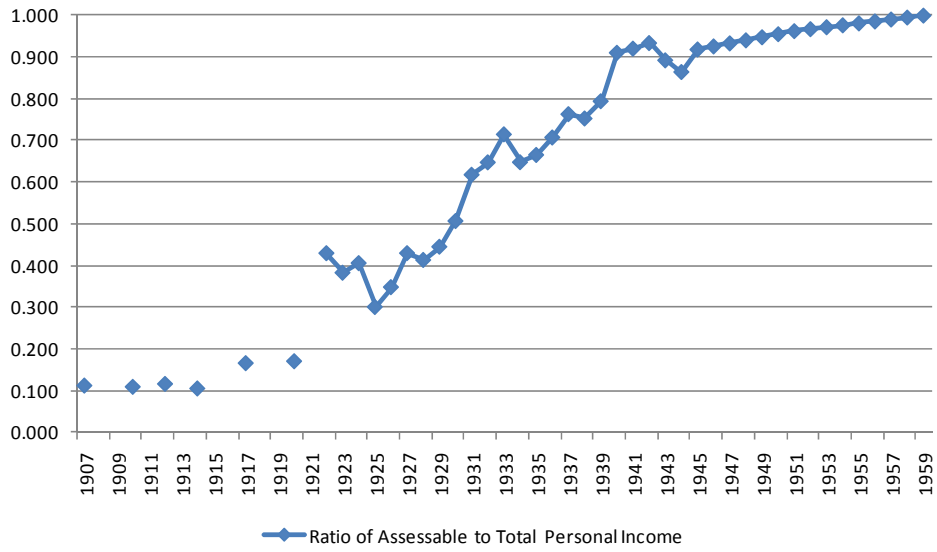
To estimate non-filers in years between censuses we follow the approach of Barro and Sahasakul (1983) who suggest that the proportion of non-filer income to total income fluctuated during different economic conditions, such as the depression in the 1930s. They show, as expected, that there is a higher proportion of non-filer to total income during the depression for the U.S. (Barro and Sahasakul, 1983, Table 1), while the proportion decreased in years of greater prosperity during the 1920s. Barro-Sahasakul also use the ratio of personal income to nominal GNP to estimate the relevant non-filer to filer income ratio for earlier years.

We follow the same approach here and extend estimates based on census years. Using our estimates for non-filer incomes in 1926, 1936, 1945, and 1951, aggregated personal income is found by adding the non-filers adjustment to total (filers') assessable income. Using the ratio of this total personal income to GNP for the four census years, we extend this ratio linearly to fill in all other years. Personal income for missing years is then found by multiplying this ratio with annual GNP. Finally non-filer income is obtained by subtracting the assessable from the total personal income.

The above approach (using the personal income to GDP ratio) produces a generally increasing ratio of filer to total assessable income from 1926 to 1951 (0.347, 0.707, 0.919, 0.963). However between 1945 and 1951, this produces an estimated negative amount of non-filer income in some intervening years. To interpolate between 1945-51 we therefore interpolate linearly between the filers/total income ratios of 0.919 and 0.963. From 1958 the introduction of PAYE taxation renders the non-filers adjustments unnecessary for subsequent years.

While this approach undoubtedly involved various inaccuracy (of unknown magnitude) it is likely to be more accurate as a method of filling in missing years between the census, and before 1926, than taking simple linearly interpolated averages. The resulting time-series for the ratio of filers-to-total personal income and the breakdown of filer and non-filer incomes are given in Figures A2 and A3 respectively.

**Figure A3 – Ratio of filers-to-total personal incomes, 1907-1958**



**Figure A4 – Decomposition of total personal income into filers/non-filers, 1907-1958**

