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A Growth Maximising Tax Structure for New Zealand*

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Abstract

Annual growth rates of real GDP in New Zealand have varied widely, from 18% to −8%, since World War II. During this period the tax burden (the ratio of tax revenue to GDP) has trended upward from 23% to 35%. The tax mix (the ratio of indirect taxes to direct taxes) has varied between 0.31 and 0.75, having increased recently with the introduction of the goods and services tax. In this paper we estimate a combination of the tax burden and the tax mix which would maximise the rate of growth of real GDP. We find that such a tax structure would have a time-varying tax burden with a mean of 22.5%, and a time-varying tax mix with a mean of 0.54, which implies a mean share of direct taxes in total tax revenue of 65%. We also find that a move to such a tax structure would generate nearly a 17% increase in real GDP, and while this increase would yield a 6% reduction in tax revenue to the Treasury, it would deliver a 27% increase in purchasing power to the remainder of the economy.

Keywords: size of government, tax structure, economic growth

JEL Code: H11, H21, C51, C61

1. Introduction

The widely heralded liberalisation of New Zealand's economy began in the early 1980s. The reforms were both macroeconomic and microeconomic in scope. The former included changes in the conduct of fiscal and monetary policy. Among the latter were liberalisation of international trade, deregulation of domestic industrial, agricultural, finance and labour markets, widespread corporatisation and privatisation, social welfare reform, and reform of the tax system. Reform of the tax system included a reduction in the progressivity of personal income taxes and a reduction in corporate tax rates, an overall broadening of the

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income tax base, and the introduction of a comprehensive goods and services tax (GST). The reforms have transformed New Zealand from one of the most regulated economies in the OECD to one of the least regulated.[1]

The transformation has not been easy. From the mid-1980s through 1992 the economy performed poorly as it went through the painful adjustment process. During this period real GDP declined by 1.5%, and rates of inflation and unemployment reached double-digit levels. However, since 1993 the economy has rebounded. Growth has returned, and inflation and unemployment have moderated, although the Asian financial crisis has taken its toll in 1998 and 1999.

There is one feature of the reforms on which little progress has been achieved. The tax system has been partially reformed by flattening the tax scale and broadening the tax base. However, the overall level of taxes has actually increased, and the ratio of direct to indirect taxes remains relatively high despite the introduction of the GST. During the decade prior to the onset of liberalisation the tax burden (the ratio of Treasury tax revenue to GDP) averaged 30%, and the share of direct taxes in tax revenue averaged 75%. During the post-liberalization decade the tax burden has increased to an average of 33.2%, while the share of direct taxes in tax revenue has declined only to 67%. In the eyes of some observers, additional reform requires a reduction in the tax burden, so as to transfer resources from the public sector to the deregulated private sector, and a continuing reduction in the reliance on direct taxes, so as to reduce avoidance and evasion. Both reforms, it is argued, would enhance economic growth.

Annual rates of growth of New Zealand's real GDP have fluctuated widely during the post-World War II period. Annual growth rates of 12% and 18% were achieved in 1950 and 1951, and negative annual growth rates occurred in eleven years, most recently during the early liberalisation years of 1988, 1990 and 1991. Overall, the mean annual growth rate has been 3.09%. The tax burden has varied much less, declining from 29% in 1946 to 23% in 1964, then increasing to 30% in 1988, and rising sharply after the introduction of the GST in 1988. The 1995 tax burden was 35%.[2] The postwar tax mix (the ratio of indirect taxes to direct taxes) has also been fairly stable, averaging about 0.5 from 1946 through the mid-1960s, then declining to about 0.4 for two decades, and then increasing to well above 0.5 with the introduction of the GST. The 1995 tax mix was 0.55, implying that direct taxes accounted for 64% of total tax revenue.

This brief overview raises a number of questions. Is there a relationship between the rate of growth of real GDP and the tax structure (the tax burden and the tax mix)? If so, which component of the tax structure, the burden or the mix, has the more potent impact on the rate of growth of real GDP? Is it possible to determine values of the tax burden and the tax mix that would maximise the rate of growth of real GDP? What would be the effect, on both the level and the rate of growth of real GDP, of moving to such a tax structure? Finally, what would happen to tax revenues, and to purchasing power in the remainder of the economy, if New Zealand adopted such a tax structure? The objective of this study is to provide answers to each of these questions.

Economic theory provides expectations of answers to some of these questions. In the neoclassical model of economic growth (Solow (1956)), the rate of growth of a country's real GDP is a weighted sum of the rates of growth of its labour and capital inputs, the weights being provided by the output elasticities of the two inputs, plus its rate of productivity growth. In principle, the structure of a country's tax system can influence each of the five determinants of real GDP growth, and therefore can indirectly influence real GDP growth itself. However, the neoclassical growth model also implies that changes in a country's tax structure should have no impact on its *long run* growth rate. Such changes allow a country to move to a higher or lower level of economic activity, but the new long run path grows at the same rate as the old long run path. It is only during the transition from the old path to the new path that the rate of growth of a country's real GDP increases or decreases.

Empirical research has tended to confirm an inverse relationship between observed tax burdens and observed rates of growth (of real GDP or real GDP per capita). It has also revealed a less pronounced, but nonetheless inverse, relationship between observed mixes of direct to indirect taxes and observed rates of growth.[3] Some of the empirical evidence from New Zealand is consistent with these patterns; this research suggests that tax burdens have been too high, and that the share of direct taxes in total tax revenue has been too high also, if the government's policy objective is to maximise the rate of growth of real GDP.[4] However, no previous study has asked, much less answered, the full set of questions we posed above. Consequently the objective of this paper is to conduct a comprehensive analysis of the relationship between historical and growth maximising tax structures in New Zealand since World War II.

The paper is organised as follows. In Section 2 we provide the analytical foundation for an analysis of the relationship between economic growth and the tax structure. The foundation consists of a two-stage procedure. In the first stage we use linear programming techniques to isolate factors other than the tax structure which might have influenced economic growth. In the second stage we use econometric techniques to analyse the separate impacts of the tax burden and the tax mix on economic growth, independently of the non-tax factors which were isolated in the first stage. This enables us to determine growth-maximising values of the tax burden and the tax mix, and to determine the impacts of moving to such a tax structure on the level and the rate of growth of real GDP, on Treasury tax revenue, and on purchasing power in the remainder of the economy. In Section 3 we apply the analysis to post-World War II New Zealand data. We find evidence of a strong inverse relationship between the tax burden and the rate of economic growth, and a weaker positive relationship between the tax mix and the rate of economic growth. We find a growth-maximising tax burden which varies around a period mean of 22.5%, well beneath the actual period mean tax burden of 28% and far beneath the 1995 tax burden of 35%. We find a growth-maximising tax mix having a period mean 65% share of direct taxes in total tax revenue. This share is slightly less than the observed period mean 68% share of direct taxes in total tax revenue, although it is virtually identical to the 1995 share. We find that a move to a growth-maximising tax structure would on average generate nearly a 17% increase in the level of real GDP. Such a move would have no perceptible impact on the long run rate of growth of real GDP beyond the transition period, although the transition period might be quite long. The 17% increase in real GDP, in conjunction with the 20% reduction in the tax burden, would reduce government tax revenue by almost 6% on average. As a consequence, purchasing power in the remainder of the economy would increase by 27% on average. It is this release of resources from the public sector to the private sector that would generate the higher output and the faster transition period growth. In Section 4 we provide a summary of our findings.

2. The Analytical Foundations

We begin this section with a simple version of the standard neoclassical model of economic growth, in which taxes play an indirect role. We continue by developing a linear programming model in which the non-tax influences on economic growth are isolated. We conclude by developing an econometric model in which taxes directly influence economic growth, independently of the non-tax factors that were isolated in the first stage. We calculate growth elasticities with respect to the tax burden and the tax mix, and we derive growth maximising values of the tax burden and the tax mix. We also derive the implications of moving to a growth-maximising tax structure for both the level and the rate of growth of real GDP, for the level and the composition of tax revenue, and for the level of purchasing power in the remainder of the economy.

In Solow's neoclassical growth model, a country's output is determined by its economic resources and the technology at its disposal. The rate of growth of a country's output can be expressed as

$$G_Y = G_P + \beta_L G_L + \beta_K G_K, \tag{1}$$

where G_Y is the rate of growth of a country's real GDP, G_L and G_K are the rates of growth of its labour and capital inputs, β_L and β_K are the elasticities of real GDP with respect to its labour and capital inputs, and G_P is the rate at which its productivity grows. As Engen and Skinner (1996) explain in detail, a country's tax policy can influence all five variables appearing on the right side of equation (1), and so can indirectly influence its rate of economic growth. Briefly, tax policy can influence investment in human and physical capital, thereby influencing G_L and G_K. Tax policy can also influence the allocation of labour and capital, and hence their productivities, thereby influencing β_L and β_K. Finally tax policy can influence productivity growth G_P through its effect on research and development activities.

We summarise a country's tax policy with the ratios of its real GDP to its direct tax revenue (Y/D) and to its indirect tax revenue (Y/I). Since these two variables influence all the variables on the right side of equation (1), we can replace equation (1) with

$$G_Y = f[(Y/D), (Y/I); \boldsymbol{Z}], \tag{2}$$

where $\boldsymbol{Z}$ is a vector capturing the influence of non-tax variables on economic growth.[5] Equation (2) can be interpreted as a production relationship in which the rate of economic growth G_Y is an "output" produced with tax policy "inputs" (Y/D) and (Y/I) in an environment characterised by non-tax variables $\boldsymbol{Z}$. Note that this formulation indirectly captures the influences of the tax burden $[B = (D + I)/Y]$ and the tax mix $[I/D = (Y/D)/(Y/I)]$ on economic growth.

The empirical problem with equation (2) is that many of the non-tax variables that belong in the vector $\boldsymbol{Z}$ are likely to be difficult to identify, much less to quantify, making estimation problematic. But if $\boldsymbol{Z}$ is ignored and treated as a vector of omitted variables, and if any elements of $\boldsymbol{Z}$ are correlated with (Y/D) or with (Y/I), then the resulting parameter estimates will be biased and inconsistent, and inferences concerning the influence of the tax structure on economic growth will be adversely affected. It is therefore desirable to eliminate the influence of $\boldsymbol{Z}$ on G_Y prior to the estimation of equation (2).[6]

We now formulate a linear programming model whose objective is to eliminate the influence of the unobserved elements of $\boldsymbol{Z}$ on G_Y. It constructs a *best-practice economic growth frontier* for the period, and evaluates the performance of the economy in each year relative to the frontier. Years located on the frontier define best practice growth performance relative to the tax burdens prevailing in those years, while years located beneath the frontier exhibit inferior growth performance relative to the tax burdens prevailing in those years. The unobserved non-tax influences on economic growth must have been relatively favourable in the best-practice years and relatively unfavourable in the remaining years.

The linear program seeks the smallest reciprocal tax burden (or, equivalently, the heaviest tax burden) which is consistent with an observed growth rate, given a history of observed growth rates and tax burdens. Suppose we observe G_Y^t, $(Y/D)^t$ and $(Y/I)^t$ for a sequence of years $t = 1, \ldots, T$, and consider the following linear programming problem:[7,8]

$$\begin{aligned} &\min_{\theta,\lambda} \theta && (3)\\ &\text{subject to} \quad \theta(Y/D)^{\mathrm{o}} \geq \sum_t \lambda^t (Y/D)^t \\ &\qquad\qquad\quad \theta(Y/I)^{\mathrm{o}} \geq \sum_t \lambda^t (Y/I)^t \\ &\qquad\qquad \sum_t \lambda^t (G_Y)^t \geq G_Y^{\mathrm{o}} \\ &\qquad\qquad\qquad \lambda^t \geq 0 \qquad t = 1, \ldots, \mathrm{o}, \ldots, T \\ &\qquad\qquad\quad \sum_t \lambda^t = 1. \end{aligned}$$

This program is solved T times, once for each year in the sample period. For year "o" the program seeks the largest equiproportionate reduction in its ratios $(Y/D)^{\mathrm{o}}$ and $(Y/I)^{\mathrm{o}}$ or, equivalently, the largest increase in its tax burden $B^{\mathrm{o}} = (D^{\mathrm{o}} + I^{\mathrm{o}})/Y^{\mathrm{o}}$, consistent with $T + 4$ constraints. The first two constraints require that the increased tax burden in year "o" not exceed a linear combination of tax burdens observed in some other years. The third constraint requires that the growth rate in year "o" not exceed a linear combination of growth rates observed in some other years. The final $T + 1$ constraints require that the linear combinations be convex combinations with nonnegative weights.

The solution values of θ^t provide an indication of the performance of the economy in various years, in terms of whether the growth rate achieved could have borne a higher tax burden (or, conversely, whether a higher growth rate could have been achieved with the observed tax burden). The solution values of θ^t satisfy $0 < \theta^t \leq 1$. If $\theta^t = 1$, that year's growth rate and tax burden were not exceeded by a convex combination of growth rates and tax burdens observed in any other years. The economy managed to achieve its growth rate despite a relatively heavy tax burden, and it follows that non-tax influences on G_Y^t must have been relatively favourable that year. If $\theta^t < 1$, that year's growth rate and tax burden were exceeded by a convex combination of growth rates and tax burdens observed in some other years. The economy achieved its growth rate with a relatively light tax burden, and it follows that non-tax influences on G_Y^t were relatively unfavourable that year.

Summarising, as $\theta^t \to 1$ the non-tax dimensions of the economic environment become more favourable, and as $\theta^t \to 0$ these factors become less favourable. Thus, we interpret θ^t as a normalised (on (0,1]) proxy for the unobserved non-tax influences on economic growth. This is the objective of the linear programming exercise, to generate annual proxies for the unobserved elements of $\boldsymbol{Z}^t$.

The second stage of the analysis is based on equation (2), with two modifications and a restriction. First, we replace $(Y/D)^t$ and $(Y/I)^t$ with the tax burden $B^t = (D + I)^t/Y^t$ and the tax mix $M^t = (I/D)^t$. This transformation involves no loss of information, and it enables us to focus directly on the two tax structure variables of interest. Second, we replace annual values of the unobserved non-tax influences $\boldsymbol{Z}^t$ with calculated values of their proxy θ^t. These two modifications yield the estimable expression $G_Y^t = f(B^t, M^t; \theta^t)$. However, we can simplify this expression by normalising B^t by θ^t to obtain $G_Y^t = g(B^t/\theta^t, M^t)$. The normalisation amounts to an upward scaling of the tax burden from B^t to $(B/\theta)^t$ in each year in which non-tax influences on economic growth were relatively unfavourable ($\theta^t < 1$), but it has no impact on the tax mix in any year. The restricted specification is consistent with the structure of the first stage linear programming model. It is also a (testable) special case of the more general specification $G_Y^t = f(B^t, M^t; \theta^t)$.

Writing the restricted growth equation $G_Y^t = g(B^t/\theta^t, M^t)$ in log-quadratic form, we have

$$\begin{aligned}\ln(G_Y)^t = \beta_o + \beta_B \ln(B/\theta)^t + \beta_M \ln M^t + (1/2)\beta_{BB}[\ln(B/\theta)^t]^2 \\ + (1/2)\beta_{MM}[\ln M^t]^2 + \beta_{BM}[\ln(B/\theta)^t][\ln M^t]. \qquad (4)\end{aligned}$$

The elasticities of growth with respect to the (unnormalised) tax burden and the tax mix are

$$\begin{aligned}\varepsilon_{GB}^t &= \beta_B + \beta_{BB} \ln(B/\theta)^t + \beta_{BM} \ln M^t \\ \varepsilon_{GM}^t &= \beta_M + \beta_{BM} \ln(B/\theta)^t + \beta_{MM} \ln M^t.\end{aligned} \qquad (5)$$

A comparison of these two elasticities provides an indication of which component of the tax structure exerts the stronger influence on economic growth.

It is possible to determine growth-maximising tax rates and tax mixes that vary through time, as economic conditions change. Time-varying values of the tax burden that maximise economic growth, *conditional on annual values of the tax mix*, can be obtained by setting the first elasticity in equation (5) equal to zero. This yields the time-varying growth-maximising tax rate

$$B^{t^*} = \theta^t \times \exp\{-(\beta_B + \beta_{BM} \ln M^t)/\beta_{BB}\}. \qquad (6)$$

Substituting B^{t^*} from equation (6) into equation (4) and exponentiating yields a rate of growth $G_Y^{t^*}$ which is maximal in the limited sense that it is conditioned on (B^{t^*}, M^t). Time-varying values of the tax mix which maximize economic growth, *conditional on annual values of the normalised tax burden,* can be obtained by setting the second elasticity in equation (5) equal to zero. This yields the time-varying growth-maximising tax mix

$$M^{t^*} = \exp\{-(\beta_M + \beta_{BM} \ln(B/\theta)^t)/\beta_{MM}\}. \qquad (7)$$

Substituting M^{t^*} from equation (7) into equation (4) and exponentiating yields a rate of growth $G_Y^{t^*}$ which is maximal in the limited sense that it is conditioned on (B^t, M^{t^*}).[9]

It is important to note that $G_Y^{t^*}$ represents the rate of growth of real GDP which prevails during the transitional shift from Y^{t-1} on the previous long run path associated with (B^{t-1}, M^{t-1}) to Y^{t^*} on the new long run path associated with (B^{t^*}, M^t) or (B^t, M^{t^*}). In the event that an existing tax structure (B^{t-1}, M^{t-1}) is replaced by a growth-maximising tax structure (B^{t^*}, M^t) or (B^t, M^{t^*}), the transitional growth rate $G_Y^{t^*}$ is expected to exceed the long run rates of growth of both observed output and output generated by a growth maximising tax structure.

The impact on output of moving to a growth-maximising tax structure in any given year can be determined by comparing output $Y^{t^*} = (1 + G_Y^{t^*}) \times Y^{t-1}$ with the output which the existing tax structure would have generated, namely $Y^t = (1 + G_Y^t) \times Y^{t-1}$. The output loss associated with the existing tax structure is thus

$$(Y^{t^*} - Y^t) = \left(G_Y^{t^*} - G_Y^t\right) \times Y^{t-1}. \tag{8}$$

The output loss can be expressed as a percent of year t output by dividing by Y^t, and it can also be expressed as a percent of year t tax revenue by dividing by $R^t = B^t \times Y^t$. Regardless of how the output loss is expressed, however, the analysis assesses the impact on output of a one-off shock to the tax structure in a given year, without cumulating the output effects through time. The rate of growth along the long run path can be determined from equation (8) by adding Y^t to each side and calculating the rate of growth of Y^{t^*}. This rate of growth can be compared with the observed rate of growth G_Y^t.

A final step is to highlight the distribution of the output loss. The additional output that would result from a shift to a growth maximising tax structure would be subject to taxation (at the growth maximising rate B^{t^*}). Thus

$$\begin{aligned}(Y^{t^*} - Y^t) &= B^{t^*} \times \left(G_Y^{t^*} - G_Y^t\right) \times Y^{t-1} + (1 - B^{t^*}) \times \left(G_Y^{t^*} - G_Y^t\right) \times Y^{t-1} \\ &= \left[B^{t^*} G_Y^{t^*} - B^t G_Y^t\right] \times Y^{t-1} + \left[(1 - B^{t^*}) G_Y^{t^*} - (1 - B^t) G_Y^t\right] \times Y^{t-1}\end{aligned} \tag{9}$$

decomposes the output loss into tax revenue lost to the Treasury and aftertax purchasing power lost to the rest of the economy. The first line of equation (9) follows directly from equation (8). However, the second line provides a more appropriate basis for the decomposition of the output loss. This is because the first line applies B^{t^*} to both $G_Y^{t^*}$ and G_Y^t, while the second line applies B^{t^*} to $G_Y^{t^*}$ and applies B^t to G_Y^t. The decomposition provided by the second line of equation (9) also can be expressed in percentage terms by dividing by Y^t or by R^t.

It is also possible to calculate the growth maximising (total, direct and indirect) tax revenue, and to compare it with observed tax revenue. In any given year, growth maximising tax revenue is $R^{t^*} = B^{t^*} \times Y^{t^*}$. This can exceed or fall short of observed tax revenue $R^t = B^t \times Y^t$ according as (B^{t^*}/B^t) exceeds or falls short of (Y^t/Y^{t^*}). Tax revenue increases if the reduced tax burden is more than offset by an increase in taxable output, and declines otherwise. Growth maximising direct tax revenue is $D^{t^*} = (1/1 + M^{t^*}) \times R^{t^*}$, which can be compared with observed direct tax revenue $D^t = (1/1 + M^t) \times R^t$. Growth maximising indirect tax revenue is $I^{t^*} = (M^{t^*}/1 + M^{t^*}) \times R^{t^*}$, which can be compared with observed indirect tax revenue $I^t = (M^t/1 + M^t) \times R^t$. The relationships between growth maximising and observed direct tax revenue, and between growth maximising and observed indirect tax revenue, depend on the relationships between the growth maximising tax mix

M^{t^*} and the observed tax mix M^t, and between growth maximising tax revenue R^{t^*} and observed tax revenue R^t.

All of the effects considered thus far—the effects on economic growth, on output, on the decomposition of output change into tax revenue change and purchasing power change, and the decomposition of tax revenue change into direct tax revenue change and indirect tax revenue change—represent *current* costs of maintaining the existing tax structure, or *current* benefits of adopting a growth maximising tax structure. They do not represent *cumulative* costs or benefits resulting from changes made or not made in years past. In year t, the cumulative output loss resulting from having had the existing tax structure in place in years prior to year t can be enormous, but it cannot be recovered. Such a cumulative output loss is a sunk cost of historical tax structures. Because cumulative losses are sunk, for current policy-making purposes and for assessing the health of the tax system, we do not calculate cumulative losses arising from the historical tax structure.

3. An Application to Post-World War II New Zealand

In this section we apply the two-stage analytical framework developed in the previous section to New Zealand data covering the period 1946–1995. Our objective is to identify a growth-maximising tax structure, and to quantify various aspects of the current cost of maintaining the existing tax structure.[10]

In the first stage we implement the linear program described in equation (3) to filter out the unobserved non-tax influences on economic growth. The overall mean value of θ^t is 86%, suggesting that a model that ignores these influences provides an acceptable fit to the data.[11] The best practice economic growth frontier is supported by five of the six most recent years, and by two earlier years as well. It would not have been possible to increase the tax burden in these years without sacrificing economic growth. These years are thus identified as years in which the tax burden was relatively heavy in comparison to the growth rates achieved, and it follows that the non-tax dimensions of the economic environment must have been relatively favourable in these years. At the other extreme are years well inside the growth frontier, with the years 1956–1958, 1960, and 1963–1970 all having values of θ^t below 75%. In these years it would have been possible to increase the tax burden with no sacrifice in economic growth. These years are thus identified as years in which the tax burden was relatively light in comparison to the growth rates achieved, and it follows that the non-tax dimensions of the economic environment must have been relatively unfavourable in these years.[12]

We proceed by normalising the annual tax burdens B^t by dividing them by their performance scores θ^t. The impact of this normalisation is evident in Figures 1 and 2. In Figure 1 there appears to be at best a very weak inverse relationship between the tax burden and the rate of growth of real GDP. However, in Figure 2 a more transparent inverse relationship emerges; abstracting from non-tax influences, low tax burdens are associated with high rates of growth of real GDP, while high tax burdens are associated with low, even negative, rates of growth of real GDP.

We now turn to the second stage econometric analysis. We use OLS to regress G_Y^t against $(B/\theta)^t$ and M^t as in equation (4), with two adjustments. First, as noted in footnote 8, we translate G_Y^t by adding 0.08 prior to taking natural logarithms. Second, initial runs

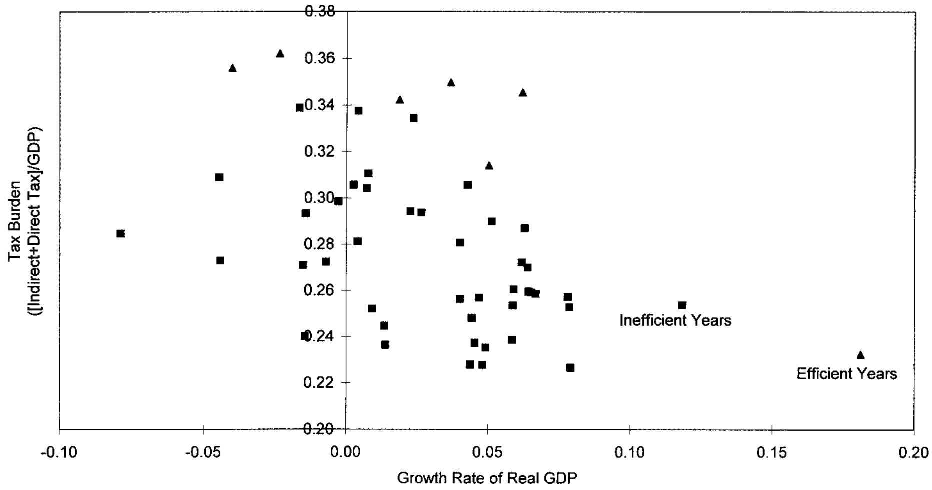

Figure 1.

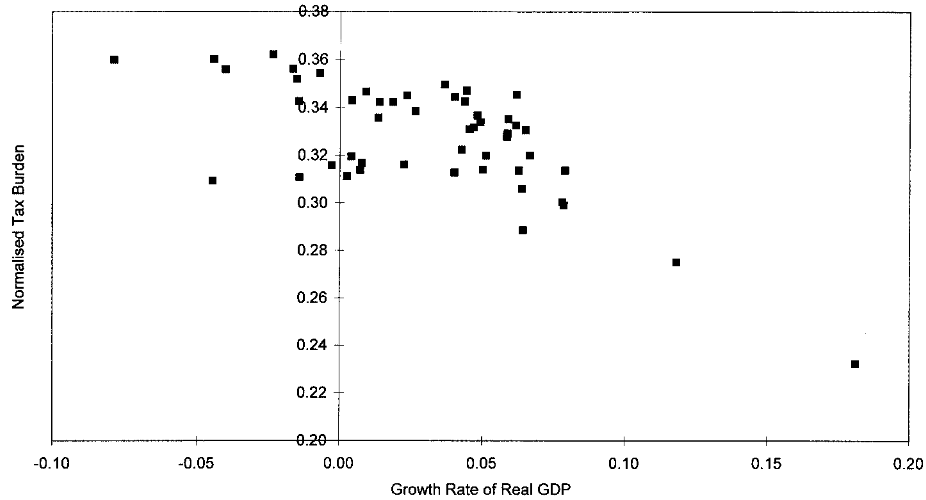

Figure 2.

identified the year 1952 as an extreme outlier, with a regression residual 5.8 standard deviations beneath the mean, and so we have added a dummy variable set equal to unity in 1952 and zero in all other years.[13,14]

Table 1 contains four sets of regression results.[15] Our preferred specification contains both the normalised tax burden and the 1952 dummy variable. The three remaining specifications delete either the normalisation or the dummy variable or both. In our preferred specification five of seven estimated coefficients are significantly different from zero, estimates of β_{BB}

Table 1. OLS parameter estimates and summary statistics 1946–1995.

Variable	Coefficient	Standard Error	T-ratio	Coefficient	Standard Error	T-ratio
Normalised burden, 1952 dummy				*Normalised burden, no dummy*		
Constant	−30.2723	5.740	−5.273	−49.4257	14.600	−3.385
$\ln(B/\theta)^t$	−43.1349	8.539	−5.052	−73.1728	21.660	−3.378
$\ln M^t$	−1.2026	5.349	−0.225	−2.8103	13.910	−0.202
$[\ln(B/\theta)^t]^2$	−34.1800	3.483	−4.907	−57.7901	8.852	−3.264
$[\ln M^t]^2$	−7.6636	0.757	−5.060	−9.2348	1.966	−2.349
$[\ln(B/\theta)^t]\,[\ln M^t]$	3.1873	4.553	0.700	2.6961	11.840	0.228
Dummy	−4.0723	0.255	−15.960			
Log likelihood	3.7062			−44.6652		
R^2 adjusted	0.8994			0.3196		
dw statistic	1.8405			2.1080		
Observed burden, 1952 dummy				*Observed burden, no dummy*		
Constant	−7.3699	6.637	−1.111	10.4509	13.020	0.803
$\ln B^t$	−6.4930	9.562	−0.679	20.4092	18.710	1.091
$\ln M^t$	−1.0730	6.716	−0.160	3.9952	13.510	0.296
$[\ln B^t]^2$	−3.8434	3.819	−0.503	16.7005	7.491	1.115
$[\ln M^t]^2$	−0.9859	1.488	−0.331	2.7700	2.982	0.464
$[\ln B^t]\,[\ln M^t]$	−0.5357	4.058	−0.132	1.7240	8.170	0.211
Dummy	−4.6353	0.398	−11.650			
Log likelihood	−18.6869			−54.3145		
R^2 adjusted	0.7537			−0.0009		
dw statistic	1.8857			1.9891		

and β_{MM} are significant and have the theoretically correct signs, the coefficient on the 1952 dummy variable is negative and significant as expected, and the adjusted R^2 is a very satisfactory 0.90. However, when the 1952 dummy variable is deleted from the preferred specification, four of six estimated coefficients remain significant, but the adjusted R^2 declines to 0.32. And when the tax burden is not normalised, only the coefficient on the 1952 dummy variable remains significant, and the adjusted R^2 declines to 0.75. Finally, when the tax burden is not normalised and the 1952 dummy variable is not included, all information is lost. No estimated coefficient is significant, the estimates of β_{BB} and β_{MM} have incorrect signs, and the adjusted R^2 is zero. This comparison provides a dramatic illustration of the value of the first stage of the analysis. By filtering out the unobserved non-tax dimensions of the economic environment in the first stage, normalising the tax burden clarifies the relationship between taxes and growth in the second stage. Without such a normalisation, no such relationship is apparent.

Elasticities of growth with respect to the tax burden and the tax mix are obtained by inserting parameter estimates from our preferred specification into equations (5). Results appear in Table 2, where we report period summaries of annual estimates and 95% confidence intervals. The estimated tax burden elasticity is negative in every year but 1951, and has a mean value of −7.38. The estimated tax mix elasticity is positive in most years, and has a

Table 2. Tax burden and tax mix (indirect/direct) elasticities 1946–1995.

Summary Statistic	dlrb			dlid		
	Point Estimate	Lower Bound	Upper Bound	Point Estimate	Lower Bound	Upper Bound
Mean	−7.3799	−7.7894	−6.9703	1.1758	1.0304	1.3212
Lower quartile	−8.7714	−9.0974	−8.4455	0.2496	0.1563	0.3595
Median	−7.7217	−8.1196	−7.3989	0.9629	0.8602	1.0981
Upper quartile	−7.7217	−8.1196	−7.3989	0.9629	0.8602	1.0981
Minimum	−10.4721	−10.8815	−10.0627	−2.9380	−3.1862	−2.6898
Maximum	4.7016	4.1887	5.2146	4.1127	3.9327	4.2927

mean value of +1.18. Confidence intervals for both series are narrow. These results imply that, on average over the period, a one percent reduction in the tax burden has 6.3 times as large a favourable impact on economic growth as does a one percent reduction in the ratio of direct to indirect taxes. This result is unsurprising for two reasons. First, although direct taxes distort incentives for individuals to work and save, and for businesses to invest, indirect taxes were until recently a mixed bag of arguably equally distortionary sales and excise taxes. Consequently adjustments to the tax mix were, until the recent introduction of the GST, unlikely to have much impact on incentives, and thus were unlikely to have much impact on the rate of economic growth. Of course as the share of the GST in indirect taxes increases, the force of this argument diminishes. Second, as will become clear below, during the period the observed tax burden has been far higher than the growth maximising tax burden on average, while the observed tax mix has been much closer to the growth maximising tax mix on average. Consequently reductions in the tax burden can be expected to have major impacts on the rate of economic growth, whereas adjustments to the tax mix can be expected to have marginal impacts on the rate of economic growth.[16]

The mean observed tax burden for the period is 28%, and annual values of the tax burden have exceeded the period mean in every year since 1975. We have calculated a growth maximising tax burden, conditional on the observed tax mix, using equation (6). Period summaries of annual values of the observed and growth maximising tax burden, together with 95% confidence intervals for the latter, appear in the first four columns of Table 3. The

Table 3. Observed and growth maximising tax burden and tax mix (indirect/direct) 1946–1995.

Year	Observed Burden	Growth Maximising Burden			Observed Mix (I/D)	Growth Maximising Mix		
		Point Estimate	Lower Bound	Upper Bound		Point Estimate	Lower Bound	Upper Bound
Mean	0.2798	0.2254	0.2228	0.2280	0.4701	0.5371	0.5277	0.5465
Lower quartile	0.2530	0.2023	0.2007	0.2040	0.3955	0.5279	0.5221	0.5337
Median	0.2723	0.2272	0.2235	0.2305	0.4759	0.5399	0.5317	0.5481
Upper quartile	0.2723	0.2272	0.2235	0.2305	0.4759	0.5399	0.5317	0.5481
Minimum	0.2266	0.1793	0.1777	0.1807	0.3068	0.4658	0.4423	0.4893
Maximum	0.3621	0.2701	0.2677	0.2725	0.7480	0.5602	0.5447	0.5758

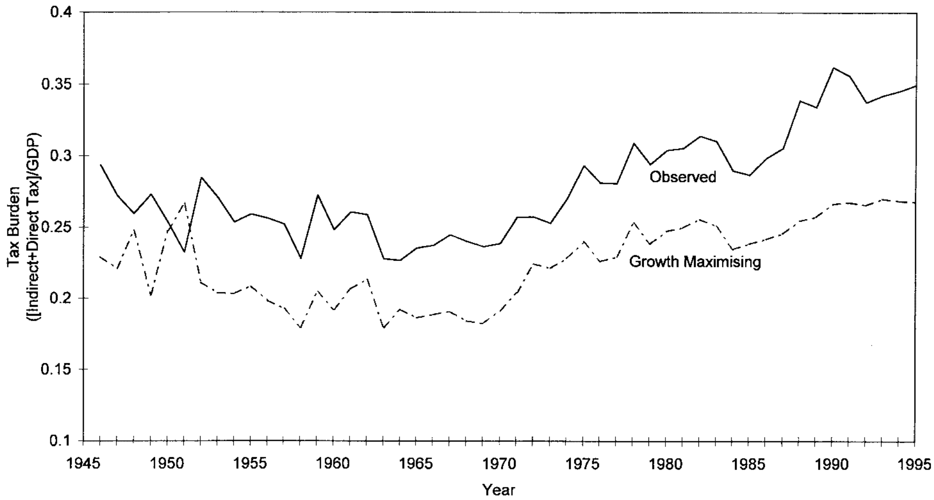

Figure 3.

growth maximising tax burden is lower than the observed tax burden in every year but 1951. The growth maximising tax burden varies from a low of 17.9% in 1963 to a high of 27% in 1993, and has a period mean of 22.5%, nearly 20% beneath the period mean observed tax burden of 28%. In 1995 the growth maximising tax burden was 26.8%, some 23% beneath the observed tax burden of 35%. Annual values of the observed and growth maximising tax burden are illustrated in Figure 3, where it is apparent that the gap between observed and growth maximising tax burdens has grown throughout much of the period.

The mean observed tax mix, defined as the ratio of indirect tax revenue to direct tax revenue, is 0.47 (a tax mix comprised of 68% direct tax and 32% indirect tax). We have calculated a growth maximising tax mix, conditional on the observed tax burden, using equation (7). Period summaries of annual values of observed and growth maximising values of the tax mix, together with 95% confidence intervals for the latter, appear in the last four columns of Table 3. The mean growth maximising tax mix is estimated to be 0.537 (implying a tax mix comprised of 65% direct tax and 35% indirect tax), and places a slightly heavier emphasis on indirect taxes than does the mean observed tax mix. However, as a consequence of the introduction of the GST, the 1995 growth maximising and observed tax mixes were virtually identical. Annual values of the observed and growth maximising tax mix are illustrated in Figure 4, where it is clear that the gap between observed and growth maximising tax mixes which prevailed for 30 years has been closed in the 1990s.

We now consider the potential consequences of a one-off shift from the observed tax structure to a growth maximising tax structure. The first two columns of Table 4 report period summaries of annual values of observed and growth maximising real GDP. The third and fourth columns report period summaries of annual values of the output gap, expressed as a percent of real GDP and as a percent of real tax revenue. The time paths of observed and growth maximising real GDP appear in Figure 5. It is important to note that *the growth maximising values of real GDP are not cumulated through time.* Each represents the effect

Table 4. Observed and growth maximising real GDP and the output gap 1946–1995.

Summary Statistic	Observed Real GDP	Growth Maximising Real GDP	Output Gap Per $ of Real GDP	Output Gap Per $ of Real Tax Revenue
Mean	47778.13	56120.00	0.17	0.60
Lower quartile	29158.14	34236.55	0.14	0.52
Median	46672.63	53691.49	0.16	0.61
Upper quartile	46672.63	53691.49	0.16	0.61
Minimum	18350.47	21610.16	0.00	0.01
Maximum	78168.64	90979.60	0.26	0.95

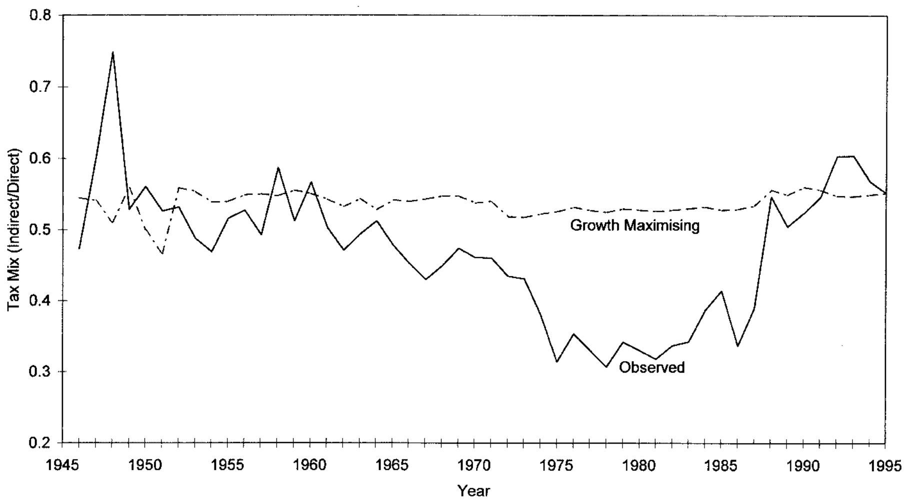

Figure 4.

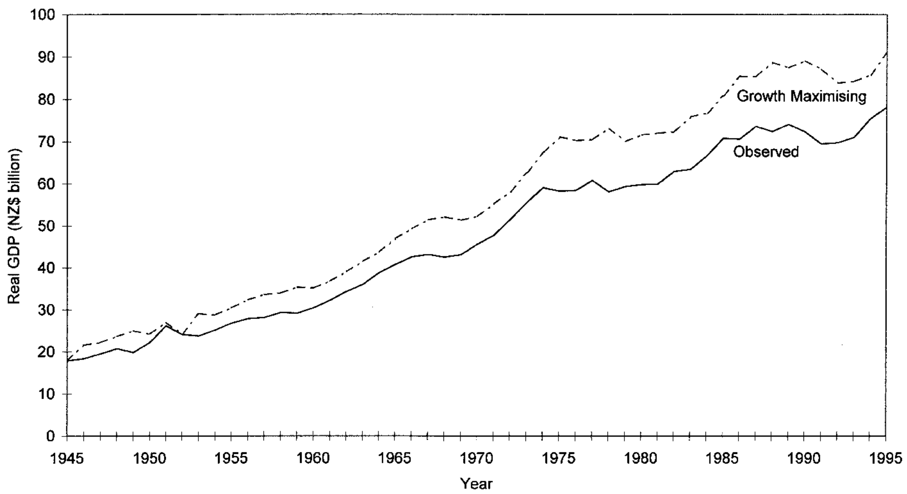

Figure 5.

of a one-off shift to a growth maximising tax structure in that year only. The output gap varies from a low of 0.4% of real GDP in 1952 to a high of 26% of real GDP in 1949 and 1978, and averages nearly 17% of observed real GDP throughout the period. Expressed as a percent of real tax revenue, the output gap varies from a low of 1% of R^t in 1952 to a high of 95% of R^t in 1949, and averages 60% of R^t throughout the period. In 1995 the output gap amounted to 16% of real GDP and 47% of real tax revenue. These figures provide perhaps the clearest indication of the cost of maintaining an existing tax structure, or the potential benefits of adopting a growth maximising tax structure—one sixth of real GDP or 60% of real tax revenue.

Although the size of the output gap, expressed as a percent of observed real GDP, has varied from year to year, it exhibits no trend. Consequently the mean rate of growth maximising real GDP is the same as the mean rate of growth of observed real GDP, 3.09% per annum over the period. Thus, consistent with the neoclassical model of economic growth, a one-off shock to the tax system has no impact on the long run rate of economic growth. It does, however, allow the economy to shift to a higher level of output, and so during the transition period (which may be long) the rate of growth accelerates.

Table 5 provides an alternative decomposition of the real output sacrificed to the existing tax system. The output gap is the difference between growth maximising and observed real GDP as reported in the first two columns of Table 5. Following equation (9), the output gap can be allocated to foregone tax revenue to the Treasury and foregone net purchasing power in the remainder of the economy. In all but four years foregone tax revenue to the Treasury is negative, and the period mean is negative. This implies that the Treasury would receive less tax revenue under a growth maximising tax structure than it would under the observed tax structure. This is because the output gap averages 16.8% of real GDP during the period (Table 4), while the tax burden would decline by 19.5% on average during the period (Table 3). Consequently the Treasury's tax receipts would decline by 5.9% per annum, on average, during the period. However, since real GDP would rise by 16.8% on average, the remainder of the economy would enjoy a 27% increase in purchasing power. The impact of moving to a growth maximising tax structure would have been even greater in 1995; real GDP would have increased by 16.4%, tax revenue would have declined by 10.8%, and the remainder of the economy would have realised a 31% increase in purchasing power. Thus, the second consequence of adopting a growth maximising tax structure is that the government would account for a smaller share of a larger economy.[17]

Since adoption of a growth maximising tax structure would involve a reduced tax burden and a reduced emphasis on direct relative to indirect taxes, the composition of the Treasury's

Table 5. The output gap and its composition 1946–1995.

Summary Statistic	Output Gap	Foregone Tax Revenue	Foregone Net Purchasing Power
Mean	8341.87	−815.31	9157.18
Lower quartile	4782.73	−1032.00	5417.63
Median	7846.03	−713.64	8648.23
Upper quartile	7846.03	−713.64	8648.23
Minimum	97.87	−3018.37	−315.09
Maximum	17701.50	1108.19	19194.67

Table 6. Growth maximising less observed tax revenues 1946–1995.

Summary Statistic	Growth Maximising Tax Revenue – Observed Tax Revenue	Growth Maximising Direct Tax Revenue – Observed Direct Tax Revenue	Growth Maximising Indirect Tax Revenue – Observed Indirect Tax Revenue
Mean	−815.31	−1067.97	252.66
Lower quartile	−1032.00	−1803.06	−248.72
Median	−713.64	−892.37	12.28
Upper quartile	−713.64	−892.37	12.28
Minimum	−3018.37	−2677.19	−1273.13
Maximum	1108.19	919.78	2162.53

tax revenues would change. A period summary of annual results is provided in Table 6. As indicated previously, tax revenue would decline by 5.9% on average over the period. Direct tax revenue would decline by 11.6% on average over the period, while indirect tax revenue would increase by 6% on average over the period. This is due to the fact that the observed tax mix has placed excessive emphasis on direct taxes during most of the period (Table 3 and Figure 4). In 1995, however, tax revenue and both of its components would decline by 10.8% because the observed and growth maximising tax mixes were essentially the same in 1995.

The results of our empirical analysis can be summarised as follows. *First*, direct taxes have exerted a much greater adverse influence on economic growth than indirect taxes have. *Second*, an excessive tax burden has done much more damage to economic growth than has a tax mix that has placed excessive emphasis on direct taxes relative to indirect taxes. Our econometric results suggest that an excessive tax burden has been at least six times as damaging as an inappropriate tax mix. *Third*, we have found a mean growth maximising tax burden of 22.5% of GDP, well beneath the actual mean tax burden of 28%. The 1995 growth maximising tax burden of 26.8% was even farther below the actual 1995 tax burden of 35%. *Fourth*, we have found a mean growth maximising tax mix comprised of 65% direct taxes and 35% indirect taxes. This is fairly close to the actual mean tax mix featuring 68% direct taxes and 32% indirect taxes. The actual tax mix in 1995 was virtually the same as the growth maximising tax mix. *Fifth*, we calculate the output foregone to the existing tax structure or, equivalently, the increase in output which would result from a one-off shift to a growth maximising tax structure, to have been about 17% of actual output, or about 60% of actual tax revenue, over the period. *Sixth*, we find that under a growth maximising tax structure, Treasury tax revenues would decline by an average of nearly 6% per annum over the period. As a consequence, under a growth maximising tax regime, private sector purchasing power would increase proportionately more than real GDP would increase, by 27% on average over the period.

4. Summary and Conclusions

A nation's tax structure has important consequences for the rate at which its economy grows. In this paper we have attempted to uncover the relationship between New Zealand's tax structure and the rate of growth of its real GDP. Two assumptions underlie our analysis. The first assumption is that in evaluating the structure of the tax system, the driving policy objective is one of maximising the rate of growth of real GDP. It is possible that different policy objectives would lead to different evaluations. The second assumption is that the tax structure is adequately characterised by two dimensions: the tax burden and the tax mix.

In the Introduction we asked five questions concerning taxation and economic growth in New Zealand. In Section 2 we developed an analytical framework capable of providing answers to each of these questions. In Section 3 we applied this framework to New Zealand macroeconomic data covering the period 1946–1995 in an effort to provide quantitative answers to each of these questions. We have found that an excessive tax burden has done far more damage to economic growth than has an inappropriate tax mix. However, the damages are measured, reducing the tax burden is a more potent way of enhancing economic growth than is fine-tuning the tax mix. This is due in part to the fact that the actual tax burden has consistently been far higher than the growth-maximising tax burden, while the actual tax mix has typically been much closer to the growth-maximising tax mix. Our second finding concerns the cost of maintaining the existing tax structure, or the potential benefit to be gained by adopting a growth maximising tax structure. One measure of the cost or the benefit is provided by the output gap, the difference between growth maximising and observed real GDP, which we estimate to have been 16.4% of observed real GDP in 1995. Another measure of the cost or benefit is provided by the composition of the output gap. We estimate that in 1995 a growth maximising tax structure would have reduced tax revenue to the Treasury by 10.8%, and would have increased purchasing power in the remainder of the economy by 31%.

Notes

1. A fascinating insider's view of the political and economic history of New Zealand's liberalisation period is provided by Brash (1996). Evans et al. (1996) provide a detailed analysis of the reforms enacted during the period.
2. It is useful to put New Zealand's 35% tax burden into international perspective. In 1994 the US, Japan and Australia were alone among OECD countries in having tax burdens (including local taxes) beneath 30% of GDP. New Zealand's inclusive tax burden of 37% was just beneath the OECD mean of 38.4%, and well beneath the 51% inclusive tax burdens in Denmark and Sweden. However, New Zealand's inclusive tax burden has grown 35% since 1970, as compared with the OECD mean growth of 30.2%.
3. Simple plots of growth rates and tax burdens (such as in *The Economist* (1996)) tend to show an inverse relationship between the two, but they make no effort to control for other influences on growth. More sophisticated econometric studies, both of time-series data within a country, and of cross-country data at a point in time, are surveyed by Engen and Skinner (1996). Generally speaking, the findings of the majority of these studies are consistent with the hypothesis that economic growth is enhanced by both a reduction in the tax burden *from current levels* and a reduction in the ratio of direct to indirect taxes *from current levels*. However, Engen and Skinner note several reasons why these findings should be treated with extreme caution. Tanzi and Zee (1997) cite three such reasons: the impact of taxes on growth may not be invariant to the composition of public expenditure, to the overall budgetary balance, or to the non-tax variables controlled in the analysis.
4. Using data spanning 1927–1994, Scully (1996) found an inverse relationship between the rate of growth of real GDP and the tax burden, for all values of the tax burden exceeding 21%, a rate not observed since 1940 and a rate well below the 1995 rate of 35%. Caragata and Small (1996) estimate an optimal tax burden of 20% of GDP and an optimal tax mix of 28% direct taxes, although their notion of "optimal" does not coincide with values which would maximize the rate of growth of real GDP. Caragata and Giles (1996) estimate an optimal

tax burden of 21% of GDP and an optimal tax mix featuring 33% direct taxes, "optimal" in the sense that they would minimise the size of the hidden economy and the extent of tax evasion. A summary of these and other studies appears in Caragata (1997).

5. In addition to capturing the influence of non-tax variables on G_Y^t, $\boldsymbol{Z}^t$ also captures the influence of changes in the composition of D^t and I^t on G_Y^t. For example, the ratio of personal to corporate tax revenues in direct tax revenues has ranged from 1.96 in 1957 to 8.98 in 1984, with a period mean of 4.19. The composition of indirect tax revenues has also varied during the period, particularly since the introduction of the GST in 1988. The impact of the introduction of the GST may in fact show up in our empirical results, which suggest that the non-tax environment improved beginning in 1990, presumably because indirect taxes became less distortionary.
6. It would in principle be possible to estimate equation (2) using instrumental variables techniques. We have not done so because (i) our small sample size renders the consistency property of any IV estimator of little practical value, (ii) it would be difficult to select instruments which are correlated with the elements of $\boldsymbol{Z}$ and uncorrelated with the regression error term, and (iii) parameter estimates are likely to be sensitive to the selection of instruments. Each of these difficulties is avoided by the alternative approach we have adopted.
7. This linear programming model is known as Data Envelopment Analysis (DEA) because it envelops the data, forming a best practice production frontier. It is commonly used to evaluate the relative productive efficiency of each producer in a sample. Here we use it for a new and entirely different purpose, to construct a best practice economic growth frontier and to evaluate the relative growth performance of each year in the sample. This in turn enables us to adjust annual tax burdens for variation in annual non-tax influences. A comprehensive introduction to DEA, together with extensive bibliography and empirical applications, is provided in Charnes et al. (1994).
8. The vector $\boldsymbol{Z}^t$ of non-tax variables that might influence G_Y^t does not appear in program (3) because these variables are unobserved. The program has been converted from a burden-maximising one to a reciprocal burden-minimising one for a technical reason. Lovell and Pastor (1995) have shown that a maximising problem is not invariant to a translation of "outputs" such as G_Y^t, but a minimising problem is invariant to such a translation. Such a translation is required because $G_Y^t < 0$ in 11 years of the sample period, and so G_Y^t must be replaced with $[G_Y^t + \alpha]$, where $\alpha > |\min_t\{G_Y^t\}|$.
9. The second order conditions for maxima in equations (7) and (8) require that $\beta_{BB} < 0$ in equation (7) and that $\beta_{MM} < 0$ in equation (8). It is also possible to substitute B^{t^*} from equation (7) and M^{t^*} from equation (9) *simultaneously* into equation (5) and exponentiate to yield a maximised rate of growth $G_Y^{t^*}$. However, this growth rate would be constant rather than time-varying, and we do not recommend this strategy.
10. Real GDP and real tax revenue are nominal values normalised by the CPI, which is based at 1,000 in the December quarter of 1988. All data are derived from a Macroeconomic Tax Data document provided by the Taxation Economics Group at the New Zealand Inland Revenue Department.
11. Annual values of θ^t, and annual calculations underlying all subsequent tables, are available from the authors on request.
12. The growth frontier increases more than proportionately to equiproportionate increases in the two reciprocal burden variables. Consequently a one percent *reduction* in the tax burden can be expected to generate a greater than one percent *increase* in the rate of economic growth. This finding is broadly consistent with the expectation that the excess burden of taxation grows more than proportionately with the level of taxation; see Tanzi and Zee (1997) for discussion and references.
13. 1952 was a bad year, with a growth rate of real GDP of -7.9%. This was due largely to the lingering effects of a 1951 waterfront dispute, although labour unrest permeated many other sectors of the economy as well.
14. Three features of our regression model warrant mention. First, our model uses $(B/\theta)^t$ and M^t as regressors. It is possible to uncouple B^t and θ^t, and to specify a more general model containing B^t, M^t and θ^t as regressors. We have estimated such a model, and conducted a likelihood ratio test of the hypothesis that the restricted model can be rejected in favour of the more general model. The test statistic of 2.406 is not significant against χ_4^2, and so we do not reject the restricted model. Second, the Durbin-Watson bounds test does not enable us to reject the null hypothesis of no autocorrelation in the regression residuals. Third, the regressors in our model are unlagged. Since it is possible that economic growth responds with a lag to changes in the tax structure, we have re-estimated our model including lagged values of the regressors. The likelihood ratio test statistic of 8.247 is not significant against χ_5^2, and so we do not reject the restricted model.
15. We have also used maximum likelihood techniques to estimate a stochastic growth *frontier* containing the same regressors. The residual skewness parameter is statistically significant ($t = 11.267$), and the likelihood ratio

test statistic of 8.0203 is significant against χ_1^2. This suggests that the linear programming exercise has left some non-tax influences remaining in the data. However, the growth maximising tax structure implied by the stochastic frontier parameter estimates is virtually the same as that implied by the OLS parameter estimates. The period mean growth maximising tax burden is slightly lower (21.8% versus 22.5%), and the period mean growth maximising tax mix is slightly higher (featuring 61.4% direct taxes versus 65% direct taxes).

16. It may be argued that the tax mix $(I/D)^t$ can be either too high or too low to maximise the rate of growth of real GDP, with years in which $\varepsilon^t{}_{GM} < 0$ corresponding to years in which $(I/D)^t$ was too high, and years in which $\varepsilon^t_{GM} > 0$ corresponding to years in which $(I/D)^t$ was too low. On this argument the mean of the absolute values of ε^t_{GM} might provide a more accurate measure of the impact of the tax mix on economic growth. The mean of the absolute values of the annual tax mix elasticities is 1.50, not much larger than the mean of the annual tax mix elasticities of 1.18, and the tax burden remains nearly five times as potent as the tax mix in its detrimental impact on economic growth.
17. Thus discussions about the optimal tax structure can provide the basis for assessing the relative roles of government and the market in an economy. In this context, see Feldstein's (1996) search for an answer to the question of how big government should be.

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