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Modelling the Underground Economies in Canada and New Zealand: A Comparative Analysis

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Abstract

Recently there has been a resurgence of interest internationally in measuring the size of the underground economies. This has led to new approaches to this problem, and a more rigorous treatment of the associated time-series issues. In this paper we compare our recent underground economy results for Canada and New Zealand. These results provide time-series measures of the (legally-based plus illegally-based) underground economies in those countries, over similar historical periods, obtained via the same methodology. This methodology involves the estimation of structural MIMIC models, calibrated by estimating nonlinear currency-demand models. In addition to providing the underground economy measures themselves, we also compare the medium-term trends and cyclical characteristics of underground output in these two countries, and their responsiveness to changes in taxation policies. Special attention is paid to the effects on the New Zealand and Canadian underground economies of the Goods and Services Taxes in 1986 and 1991 respectively. These taxes are virtually identical in their design, but the context of their implementation led to quite different impacts on the associated underground economies.

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Introduction

The size of the "informal" or "underground" sector of an economy, and the way that it develops over time, is of considerable interest. Its existence raises interesting measurement issues, and from an economic policy-making perspective it is important to understand its magnitude and interaction with the "regular" (measured) economy. Not surprisingly, therefore, there is a significant body of both theoretical and empirical research into this topic internationally. Recent comprehensive discussions, and comparative summaries of the international evidence, are provided by Schneider and Enste (2000) and by Giles and Tedds (2000), for example. Giles (1999b) discusses some related implications for econometric modelling.

The Canadian underground economy has attracted its share of attention, ranging from the well known early contributions of Mirus and Smith (1984, 1989), to the more recent contributions of Mirus, Smith and Koroleff (1994) and Spiro (1994), among others. A useful overview of some of the Canadian issues and viewpoints can be found in the contributions in Lippert and Walker (1997).

In the context of the Canadian empirical literature on the size of the underground economy, there has been some debate over the wide range of estimates that have been obtained, and the "plausibility" of some of the larger such values. Essentially, much of this debate has arisen as a result of quite different definitions of "the underground economy" being used by different authors. At one end of the scale, one can define it to relate only to legally-based transactions that are covered by, but omitted from, GDP (or some other official output measure). At the other end of the scale, the underground economy can be defined in terms of all transactions (*legally-based or illegally based*) that generate unrecorded income. In our own work, as in much of the modern international empirical research, we take the latter position. There are many intermediate definitions that can also be used. For example, in his audit of Revenue Canada's "Underground Economy Initiative" the Auditor General of Canada (1999, para. 2.10), defines the underground economy as "legal transactions in goods and services that are 'hidden', resulting in the evasion of taxes." (This definition excludes activities such as drug trafficking, drug smuggling, prostitution, *etc.*.)

With this in mind, our estimates of the size of the Canadian underground economy that are reported here, and compared with similar estimates for New Zealand, are larger than those

reported in some other Canadian studies. They are, however, very comparable indeed with the other international evidence (*e.g.*, Schneider and Enste, 2000) that is based on a similarly broad definition of the hidden sector.

Modelling the Underground Economy

Many different methods have been used in the various empirical studies of the underground economy that have been undertaken in Canada and internationally. A thorough review of these different approaches is provided by Giles and Tedds (2000), for example. In our own work we have followed the recent trend of using "Multiple Indicator, Multiple Causes" (MIMIC) modelling to estimate a complete time-series for the size of the underground economy. This approach, which is summarized briefly below, has several advantages over the alternatives. It enables one to incorporate several different causal factors that influence underground activity, and to determine their relative significance, and MIMIC models allow one to take into account several different "signals" of underground economic activity simultaneously. They also facilitate the generation of a full time-path of the underground economy on a consistent basis.

A MIMIC model of the underground economy (Zellner, 1970, Goldberger, 1972, Jöreskog and Goldberger, 1975, Jöreskog and Sörbom, 1993a, b) is formulated mathematically as follows: η is the scalar (unobservable) "latent" variable (the size of the hidden economy); $\mathbf{y}' = (y_1, y_2, ..., y_p)$ is a vector of "indicators" for η; $\mathbf{x}' = (x_1, x_2, ..., x_q)$ is a vector of "causes" of η; $\boldsymbol{\lambda}$ and $\boldsymbol{\gamma}$ are (p×1) and (q×1) vectors of parameters; and ϵ and ζ are (p×1) and scalar random errors. It is assumed that ζ and all of the elements of $\boldsymbol{\epsilon}$ are Normal and mutually uncorrelated, with var.(ζ) = ψ, and cov.($\boldsymbol{\epsilon}$) = Θ_{ϵ}. The MIMIC model can be expressed as:

$$\mathbf{y} = \boldsymbol{\lambda}\eta + \boldsymbol{\epsilon} \qquad \textbf{(1)}$$

$$\eta = \boldsymbol{\gamma}'\mathbf{x} + \zeta \ . \qquad \textbf{(2)}$$

Substituting (2) into (1), the MIMIC model can be written as:

$$\mathbf{y} = \Pi\mathbf{x} + \mathbf{z} \ , \qquad \textbf{(3)}$$

where

$$\Pi = \boldsymbol{\lambda}\boldsymbol{\gamma}' \ ,$$

$$\mathbf{z} = \boldsymbol{\lambda}\zeta + \boldsymbol{\epsilon},$$

and $$\text{cov.}(\mathbf{z}) = \boldsymbol{\lambda}\boldsymbol{\lambda}'\psi + \Theta_{\epsilon}.$$

The p-equation multivariate regression model, (3), has a regressor matrix of rank one, and the error covariance matrix is also constrained. So, it is not possible to obtain cardinal estimates of all of the parameters. Only certain "estimable functions" of the parameters can be identified, meaning that we can estimate the *relative magnitudes* of the parameters, but not their *levels*. The estimation of (1) and (2) requires a normalization of the parameters in (1), and a convenient way to achieve this is to constrain one element of λ to some pre-assigned value.

Because both **y** and **x** are observable data vectors, the multi-equation model in (3) can be estimated by restricted Maximum Likelihood estimation (*e.g.*, using the LISREL package of Jöreskog and Sörbom, 1993a,b). This yields consistent and asymptotically efficient estimates of the elements of Π, and hence of λ and γ. Given an estimate of the γ vector, and setting the error term ζ to its mean value of zero, equation (2) enables us to "predict" *ordinal* values for η, which in our case is the relative size of the hidden economy, at each sample point. Then, if we have a specific value for η at some sample point, obtained form some other source, we can convert the within-sample predictions for η into a *cardinal* series. Frey and Weck-Hanneman (1984) estimated underground economy MIMIC models for a range of OECD countries; Aigner *et al.*(1988) applied a dynamic MIMIC model to U.S. data; and Tedds (1998) used this approach to model the Canadian underground economy. Giles (1999a) was the first author to "calibrate" such MIMIC model underground economy results formally, by using the output from a completely separate demand-for-cash model to convert the ordinal predictions into cardinal ones in the context of New Zealand data. A somewhat different demand-for-cash model was used by Giles and Tedds (2000) to calibrate the Canadian results discussed below.

In this paper we compare the latter results with those of Giles (1999a). We also compare some of the policy implications of these Canadian and New Zealand underground economy estimates. Table 1 shows the various "causal" and "indicator" variables that are used in the "preferred" models in the two studies in question. (Other variables were considered in different versions of our MIMIC models.) To the best of our knowledge, these two studies are the only ones involving MIMIC models that take proper account of the non-stationarity of the underlying time-series data, and the data have been "filtered" accordingly. Figures 1 and 2 display the basic results from these two modelling exercises in the form of historical time-series estimates of the underground economy in each country, expressed for convenience as a percentages of measured GDP.

Table 1: Variables Used in the MIMIC Models

(Canada: 1976-1995; New Zealand: 1968-1994)

Indicator Variables

Canada	*New Zealand*
Rate of growth in real measured GDP	Rate of growth in real measured GDP
Value of currency in circulation outside banks	Ratio of currency in circulation to M3
	Male labour force participation rate

Causal Variables

Canada	*New Zealand*
Registered male multiple job-holders aged 15 years or older	Rate of consumer price inflation
Income earned by self-employed persons	Index of "intensity" of income tax legislation
Nominal Canada-U.S. exchange rate	Index of degree of regulation in the economy
Real disposable income per member of the labour force	Real disposable income per member of the labour force
Unemployment rate	Unemployment rate
Ratio of corporate tax revenue to GDP	Ratio of corporate tax revenue to GDP
Ratio of indirect tax revenue to GDP	Ratio of indirect tax revenue to GDP
	Average-average statutory personal income tax rate
	Dummy variables for introduction of, and increase in, GST

Figure 1: Canadian Underground Economy

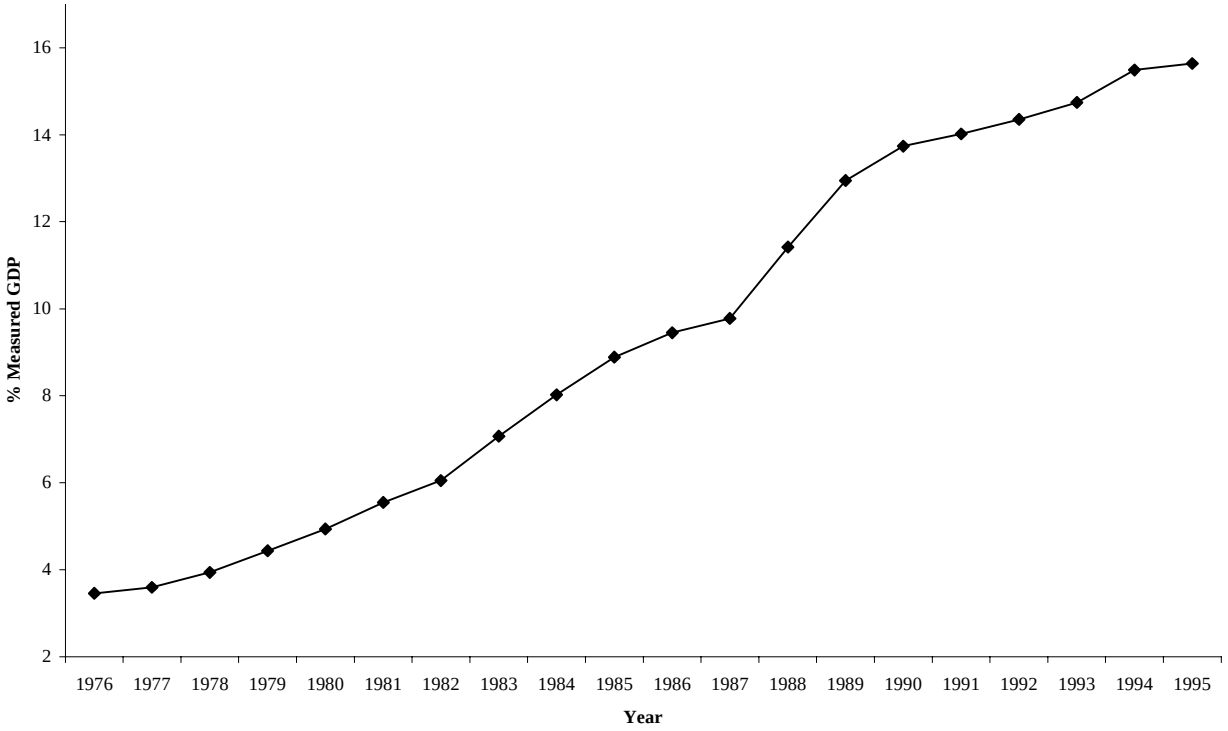
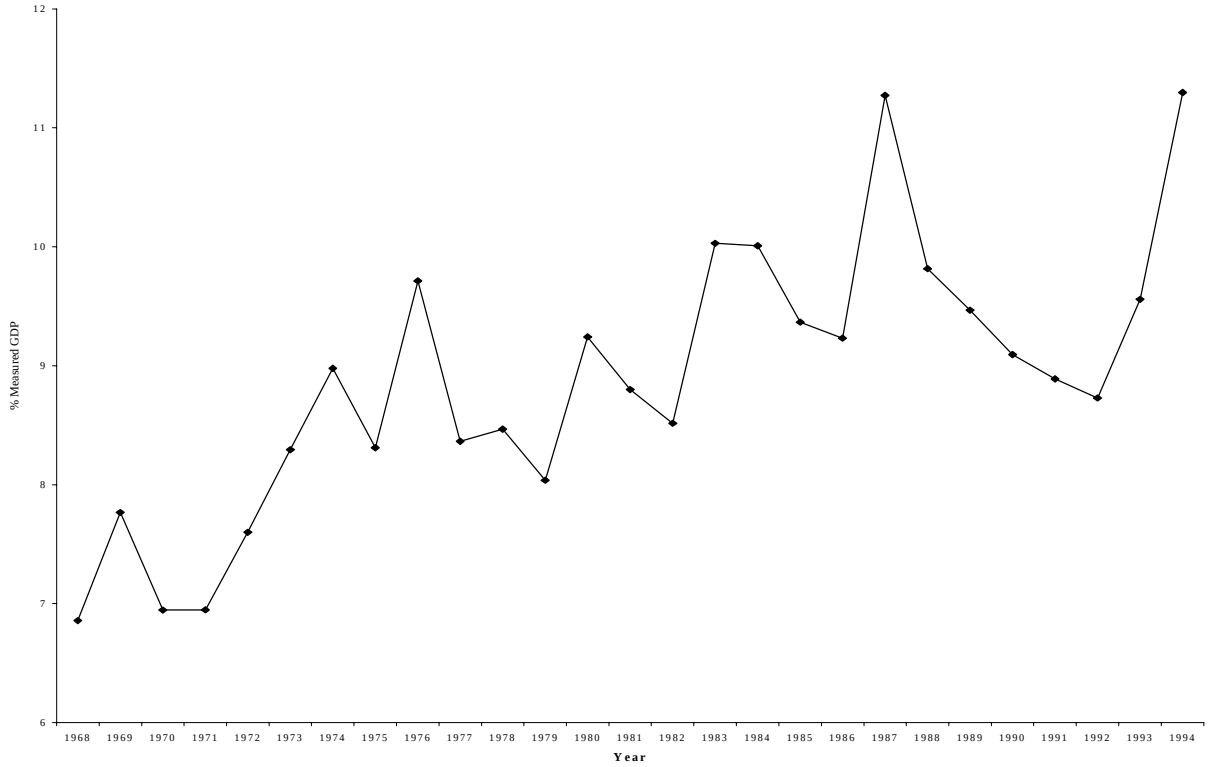
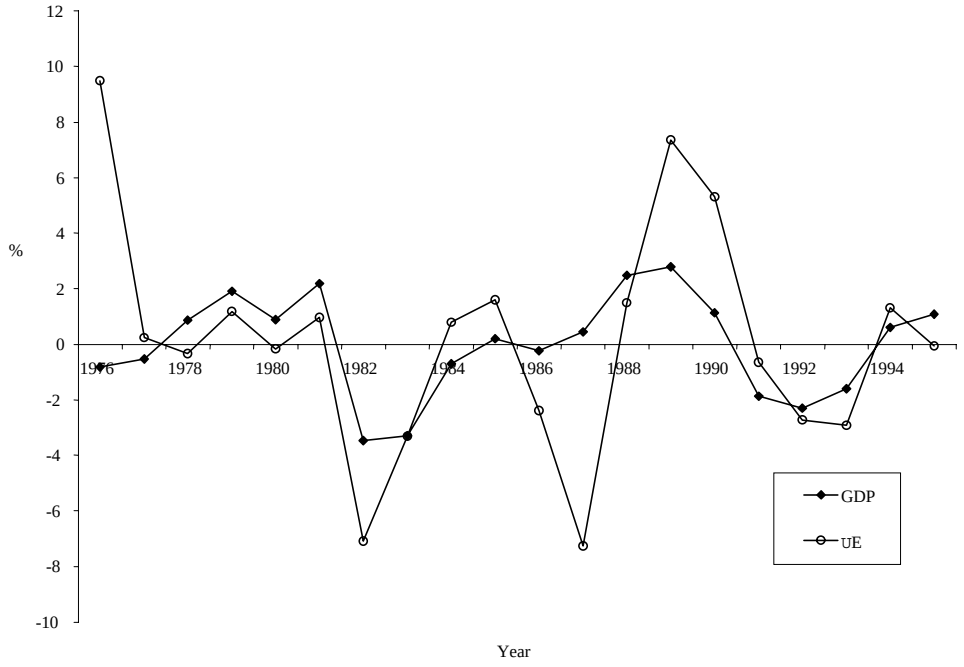


Figure 2: New Zealand Underground Economy



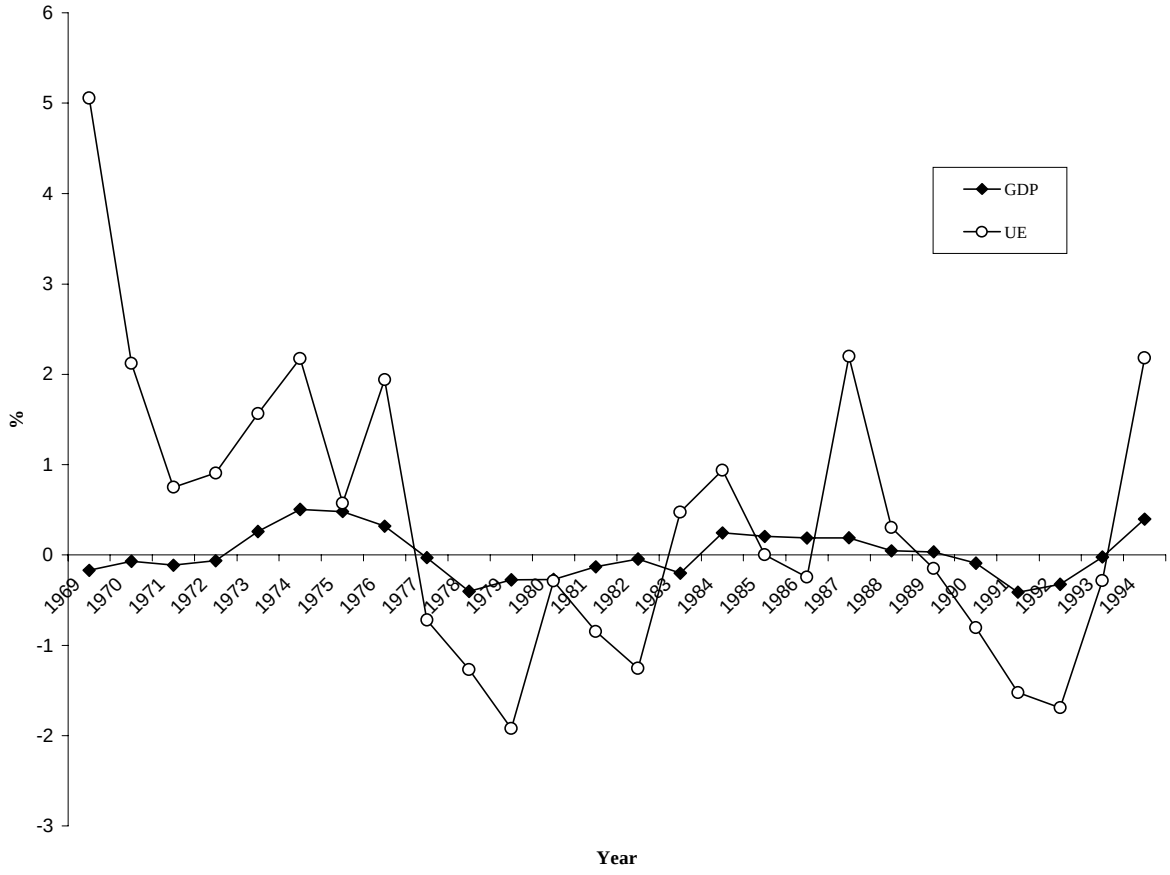
As in virtually every other country that has been studied, the underground economy (UE) grew in both countries, but the growth rate in Canada was much greater, and less erratic, then was the case in New Zealand from the mid 1970's to the mid 1990's. However, as we see in Figure 3, once the data are de-trended (using the Hodrick-Prescott, 1998, filter), the two components of the series in Figure 2 have interesting cycles. There are significant contractions in the late 1970's, in 1982, and the very early 1990's, and we can see that these arise from corresponding contractions in the cycles of *both* measured GDP and of actual UE, together with more volatile cyclical movements in the latter series than in the former. The underground economy followed the economic boom throughout the mid-1980's to late 1980's, and the later recovery starting around 1993.

Figure 3: Canadian Cycles as % Deviation From Trend



In Figure 4 we display the corresponding information for the measured and underground business cycles in New Zealand. These results are derived from the analysis in Giles (1997b). As in the Canadian case, the underground economy exhibits more cyclical movement than does measured output, and upturns in the latter appear to "lead" upturns in the underground economy's cycle.

Figure 4: New Zealand Cycles as % Deviation From Trend



Causality Between the Measured and Underground Economies

One would expect that there would be a formal connection between underground and measured outputs. However, this linkage is not a simple one, as there are several forces involved, and there are really no formal theoretical models available. In the case of agents who operate only in the informal sector, a downturn in activity in the regular economy may lead to job displacements, and this may drive more individuals into the underground economy. On the other hand, to the extent that the output of the latter sector is being consumed in the regular economy, a contraction in the latter may reduce the demand for "underground products", thus partly off-setting the first effect just noted. So, the net result will be ambiguous, and timing issues may be important.

The situation for workers who operate partly in the measured economy and partly in the hidden economy will be similar – if possible, they may substitute underground activity for regular activity when the measured economy contracts. However, if their dual activities relate to the provision of the same type of "good", as is often the case with "legally-based" underground activity, then the situation may be different. For example, a downturn in the regular economy may lead consumers to spend less on dining out, which will reduce the gratuity-based income of waiters and waitresses. If a relatively fixed percentage of the latter income is undeclared, then this component of the underground economy will shrink. However, there is an incentive for these agents to try and maintain their incomes by increasing the undeclared percentage, and this will increase the size of this part of the underground economy. Again, the net effect is ambiguous, there is no reason why this net effect will be the same as in the first situation described above, and again there could be timing differences between the positive and negative responses.

This suggests that there may be a response in the underground economy to changes in the measured business cycle. That is, there is a causal influence from the measured to the hidden economies. However, what about the converse situation? Would one expect a change in the size of the underground economy to have an impact on the measured economy, perhaps after some lag in time?

Testing for (Granger) causality between the underground and measured sectors of the economy has been undertaken by Giles (1997a) in the case of New Zealand. Corresponding evidence for Canada is provided by Giles, Tedds and Werkneh (1999), and by Giles and Tedds (2000). In both cases the non-stationarity of the data was taken into account, and the validity of the tests was assured by following the procedures of Toda and Yamamoto (1995). For both of these countries, these studies have found that there is significant evidence of Granger causality *from* the measured economy *to* the underground economy. So, the underground economy *follows* the measured economy through the cycle, at least in some average sense over sample period, rather than *vice versa.*

This conclusion is consistent with the general impression gained from Figures 3 and 4, and it poses a dilemma for policy-makers. Their attempts to stimulate (measured) growth will also promote underground activity and increase the size of the tax-gap (although not necessarily in percentage terms), as the relevant coefficients in the estimated VAR models associated with the causality testing are positive. It remains to determine whether the *relative* size of the underground

economy, (UE/GDP), increases or decreases. Expanding on this last point, the results of Caragata and Giles (2000), Giles and Caragata (2000) and Giles and Johnson (1999) for New Zealand, and those of Giles and Tedds (2000) for Canada, show that an expansionary fiscal policy (through a reduction in the effective tax rate) will lead to a *reduction* in (UE/GDP), *ceteris paribus*. This is discussed further in the next section.

Giles (1997a) and Giles, Tedds and Werkneh (1999) also found rather weak evidence of causality in the reverse direction, namely *from* underground output *to* measured output. Bi-directional causality is consistent with a situation where agents engaged in underground economic activity are also part of the regular economy. This is very plausible in both the New Zealand and Canadian contexts.

The Tax-Underground Economy Connection

The theoretical literature on the relationship between tax rates and tax evasion has to be interpreted very carefully from an empirical viewpoint. In particular, in the spirit of the seminal contribution of Allingham and Sandmo (1972), much of this literature relates to models of what is now usually known as "pure tax evasion". In such models, it is assumed that all of the agents ("workers") in the economy earn income from only one source, and some of this income is not declared to the taxation authority. In other words models of pure tax evasion are "one-sector" models. Empirically, such models are of little interest.

Recently, a more appealing class of models has emerged. These are two-sector "underground economy" models, in which there are two sources of potential income for workers, and the probability that evasion will be detected differs between sectors. In one sector, all earned income is "visible" with respect to taxation liability, while in the other the possibility of tax evasion exists, resulting in lower before-tax wages than in the first sector. Empirically, these models are more appealing than pure "tax evasion" models as their underlying assumptions more closely match reality, and they yield interesting testable hypotheses. The form of these hypotheses is, however, somewhat complicated. As with the pure tax evasion models, quite minor changes to the assumptions of the model can result in rather major changes to the predictions of the model.

Building on earlier contributions by Watson, Kesselman (1989), Jung, Snow and Trandel (1974) and others, Trandel and Snow have recently developed a theoretical two-sector model, based on

portfolio theory relating to choice under risk. They prove that if workers' preferences exhibit decreasing absolute, and non-decreasing relative, risk aversion, then the size of the underground economy (measured in *employment* terms) increases if the marginal tax rate that is faced in both sectors is increased.

Giles and Johnson (1999) have extended the Trandel-Snow results, expressing them in terms of the relationship between the *effective* tax rate, and the (UE/GDP) ratio. Among other things, they prove that if a fixed, non-zero, range of income is untaxed, and if preferences exhibit decreasing absolute, and non-decreasing relative, risk aversion, then an increase in the average tax rate in either sector may either increase or decrease the relative size of the underground economy, measured in income (output) terms.

Accordingly, in modelling the relationship between these macroeconomic aggregates, the Trandel-Snow model predicts an *ambiguous* partial derivative, and this issue is an empirical one. Their model and its predecessors are, of course, silent on the matter of the functional form of any such relationship between the size of the tax rate and that of the underground economy. Giles and Johnson (1999) and Giles and Tedds (2000) have used nonparametric regression to estimate this relationship from New Zealand and Canadian data. The results appear in Figures 5 and 6 and indicate a positive response in the UE ratio to an increase in the effective tax rate.

Giles and Tedds (2000) undertook a similar nonparametric analysis for Canada, with taxes broken down into personal, corporate, indirect and "other" components so that the effects of changes in the "tax-mix" can be analyzed. In the case of the New Zealand underground economy, Caragata and Giles (2000) also considered tax-mix issues, but used a (parametric) logistic model for the underground economy-tax rates relationship.

The elasticities that can be computed in association with Figures 5 and 6 suggest that the New Zealand underground economy is much less responsive to changes in the effective tax rate than is the case in Canada. The modelling that has been undertaken with the effective tax rate broken down into its personal, corporate, indirect and "other" components facilitates a number of interesting simulation experiments. Some examples of these are described by Caragata and Giles (2000) and Giles and Tedds (2000). Here we will comment on only one such example – one relating to the introduction of the GST in both New Zealand and Canada.

By way of a preamble, consider the general issue of the effect on the underground economy of a tax-mix change that gives more weight to indirect taxation. Hill and Kabir (1996) note that there is a widespread belief that this sort of change in the tax-mix leads to a *reduction* in tax evasion and the size of the underground economy. However, it should be noted that Kesselman (1989) has shown that if evasion is concentrated in particular industries, then changes in the direct-indirect tax-mix may have negligible impact on the rate of tax evasion. In addition, an increase in the relative use of indirect taxation can actually increase the amount of underground activity.

In the Canadian context, Giles and Tedds (2000, Chapter 12) show empirically that a revenue-neutral change in the tax-mix, favouring more indirect taxation and less direct (personal income) taxation, *does reduce* the (relative) size of the underground economy in most years of their sample. ***The exceptions are in the early years of the 1990's***. A similar change in the tax-mix, but with indirect taxes partially replacing corporate income taxes, *reduces* the size of the underground economy unambiguously. This is the opposite to the result obtained by Hill and Kabir (1996), though it should be noted that their analysis is indirect, being based on estimated money-demand models; and they employ statutory tax rates, rather than effective tax rates. For New Zealand, Caragata and Giles (2000) also show that revenue-neutral changes in the tax-mix in favour of increased indirect taxation reduce the relative size of the underground economy.

Now consider the introduction of the Canadian GST in 1991. Giles and Tedds (2000) show that the *elimination* of the GST component of indirect taxation, with a revenue-neutral substitution of additional personal income tax, would lead to a *smaller* underground economy than actually arose over this period. It would also have been smaller (except in 1995) if an increased corporate taxes had been used instead of the GST. These results, which are shown in Figure 7, provide strong support for the earlier results of Spiro (1993), and underscore the fact that the effect of a change in the tax-mix varies over the business cycle. The GST was introduced in New Zealand in October 1986 during an expansion of the business cycle. At that time, sales taxes were abolished and simultaneously major simplifying changes were made to the personal income tax and corporate tax scales. The GST was "absorbed" into the quoted price of goods and services. Caragata and Giles (2000) show that in the absence of the GST, but with a revenue-neutral (*pro rata*) increase in personal and corporate taxes, the New Zealand underground economy would have been somewhat *larger* than its actual value in most years. Their results are summarized in Figure 8.

Figure 5: Non-Parametric Relationship Between Underground Economy and Tax Rate (Canada)

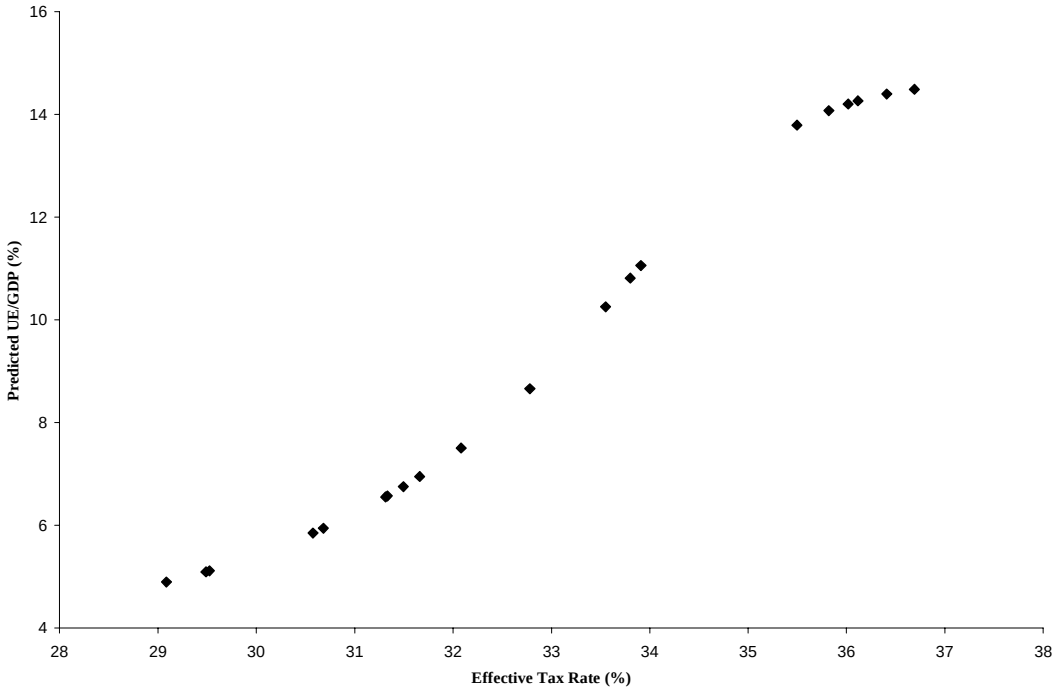


Figure 6: Non-Parametric Relationship Between Underground Economy and Tax Rate (New Zealand)

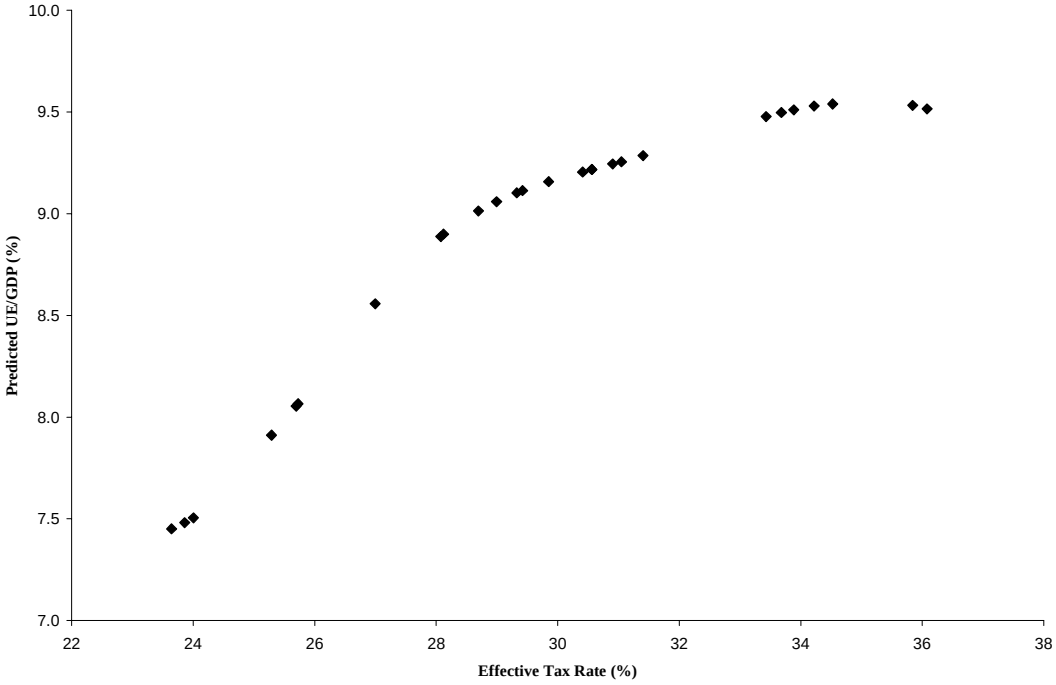


Figure 7: Replacing the Canadian GST With Increased Personal or CorporateTaxation

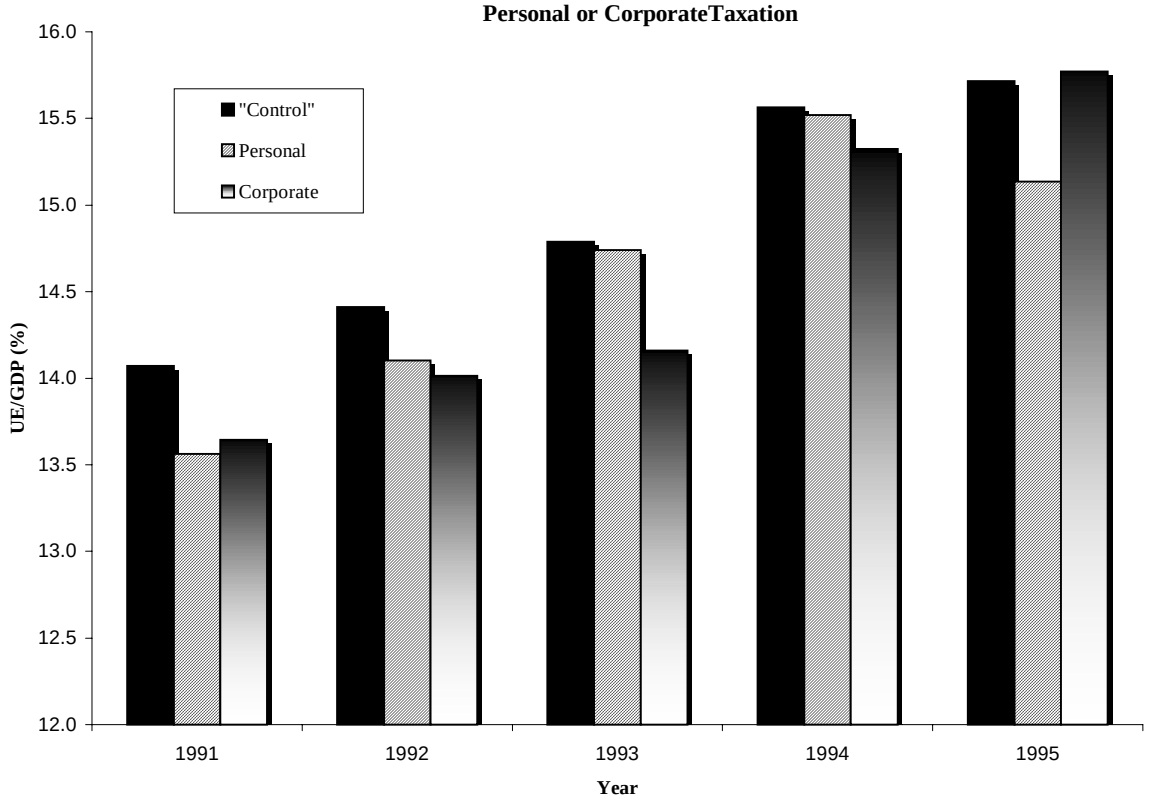
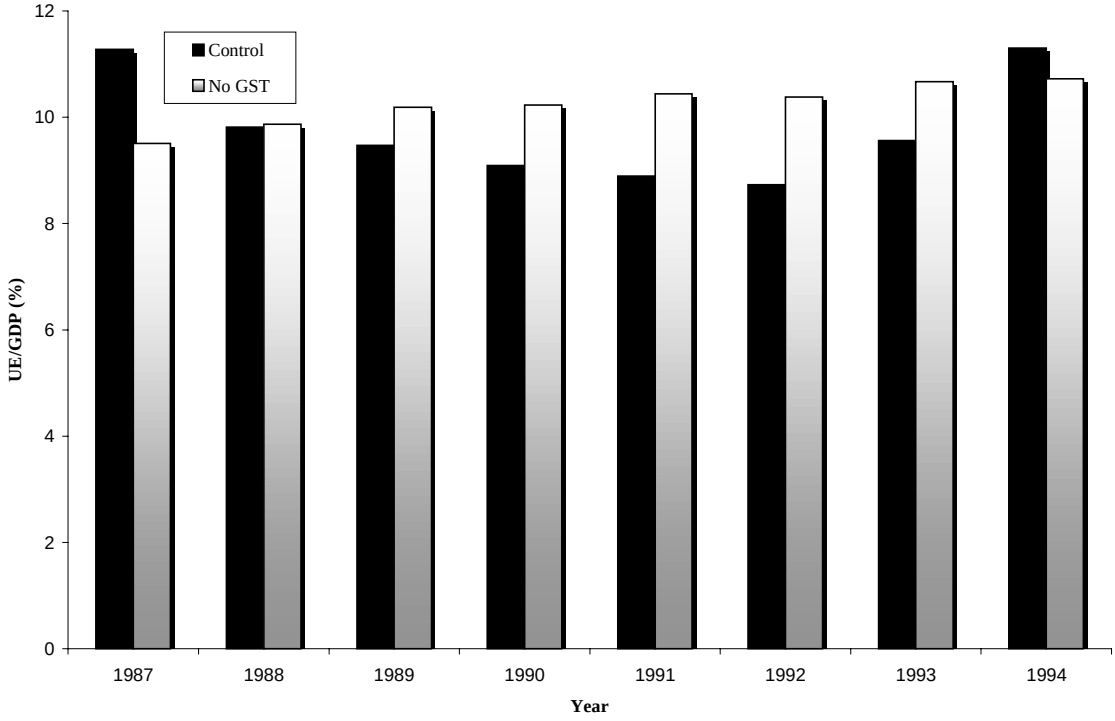


Figure 8: Replacing the N.Z. GST With Increased Personal & Corporate Taxation



Concluding Comments

This comparison of our recent research on the Canadian and New Zealand underground economies reveals both common features and some points of distinction. In both countries the underground economies have grown in recent years, but more rapidly and less erratically in the Canadian case than in New Zealand. In both countries the interaction between the measured and underground economies involves clear causality from the former to the latter, with only mild "feed-back" in the reverse direction. Similarly, in both countries an increase in the effective tax rate leads to an increase in the underground economy, as a percentage of measured GDP. With regard to changes in the tax-mix, for the most part there is agreement in the results for the two countries – a revenue-neutral change in the mix that places more weight on indirect taxation and less on direct taxation generally results in a reduction in the underground economy ratio. However, this result depends to some degree on cyclical effects and other factors. A good example of this arises with the introduction of the GST in each country. In the Canadian context our results support the view that its introduction stimulated the relative size of the underground economy. In contrast, and for reasons relating to the context of its introduction, the converse was true in New Zealand, at least in the short run.

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