MEASURING THE HIDDEN ECONOMY:

IMPLICATIONS FOR ECONOMETRIC MODELLING

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Econometrics Working Paper EWP 9809

ISSN 1485-6441

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Draft: September, 1998

In this paper I support using econometric techniques to measure the size of the hidden (underground) economy, because such information is important for the construction of certain economic models, and for empirical policy analysis. Generally, detailed information on the output of the hidden economy is unavailable. Even where careful measures of the underground economy have been constructed, usually these data are available only periodically. Important exceptions are the classic results of Tanzi (1983) for the United States, and Bhattacharyya's (1990) series for the United Kingdom. In the case of the New Zealand economy, a time-series of data on the hidden economy has been generated recently (Giles, 1997a). This provides the unusual opportunity to undertake econometric modelling in a way which takes account of such activity formally. Moreover, we can examine the policy implications arising from the linkages between hidden output and various measured economic aggregates.

Although, historically, empirical measures of the hidden economy have varied enormously in terms of the methodology employed, the reliability of the data, and the magnitudes that have been estimated, there is compelling evidence regarding certain aspects of this phenomenon. First, it seems clear that the size of the hidden economy has been growing (not only in actual nominal and real terms, but also relative to recorded GDP) over the past two or three decades, in almost all of the countries for which comparative data have been assembled[1]. Second, there is evidence that this growth in the underground economy is associated with increases in the actual or perceived tax burden. Third, there is evidence that there is a similar association between underground economic activity and the "degree of economic regulation". Rather than go into a detailed documentation of these assertions here, the reader might consult the discussion and references in Giles (1997a), Caragata and Giles (1998), and Giles and Caragata (1998), for example.

I. MEASURING THE HIDDEN ECONOMY

There is a substantial literature on the problem of measuring the size of the hidden economy. Some of the different approaches that have been used are discussed by Giles (1997a), and many other authors. These approaches include using surveys of taxation compliance; using the "initial discrepancy" between national income and national expenditure; considering fluctuations in labour force participation rates; the monetary "transactions approach" of Feige (1979); modifications of currency demand equations, at least since the pioneering work of Cagan (1958); and the use of "latent variable" structural models. These methods have their respective strengths and weaknesses, but I find the use of structural latent variable models to be encouraging. This is partly because these models take explicit account of *both* indicators of hidden activity, and potential causes, in a rigorous structural model, but also because this framework facilitates formal statistical testing of these relationships.

II. A MODELLING METHODOLOGY

In my basic work on the size of the New Zealand hidden economy I have used a two-part modelling methodology. This is detailed in Giles (1997a), but basically I estimated a MIMIC ("multiple indicators, multiple causes") structural model[2] to get a time-series index of hidden/measured output, and estimated a "demand for cash" model to obtain a benchmark for converting this index into dollar units. Unlike earlier empirical studies of the hidden economy, attention was paid to the non-stationarity of the time-series data.

MIMIC models have also been used by Frey and Weck-Hannemann (1984), Aigner *et al*. (1998), and recently by Tedds (1998) to model the underground economy. My MIMIC model treats hidden output as an unobservable "latent" variable, and uses several (measurable) causal variables and indicator variables. The former include measures of the average and marginal tax rates, inflation, real income and the degree of regulation in the economy. The latter include changes in the (male) labour force participation rate and in the cash/money supply ratio. My cash-demand equation differs from the innovative model proposed by Bhattacharyya (1990) in his study of the British underground economy: I allow for different velocities of circulation in the "hidden" and "recorded" economies; explicitly "explain" hidden activity; and avoid a functional approximation in his approach.

(*Figure 1 About Here*)

Figure 1 shows my time-series of the New Zealand hidden economy, as a percentage of real GDP, over the period 1968 to 1994. Important supportive evidence as to its recent order of magnitude is generated from actual Inland Revenue Department audit records by Giles (1998c). There is a clear downward shift in the relative size of the Hidden Economy immediately after the introduction of the goods and services tax (GST), and the simultaneous reductions in the sales, personal, and corporate tax rates in October 1986. The hidden economy follows the phases of the business cycle in New Zealand, as is confirmed in Giles (1997d, 1998a). Unrecorded economic activity increased from around 6.8% of measured real GDP in 1968 to a peak of 11.3% in 1987, then fell to 8.7% of GDP in 1992 before increasing to around 11.3% in 1994. There is a secondary effect in the cyclical decline following the *increase* in the GST rate from 10% to 12.5% in July 1989.

Various authors (*e.g.*, Allingham and Sandmo, 1972) have provided theoretical foundations for the hypothesis that underground economic activity increases with the tax burden. Figure 1 corroborates this for New Zealand, especially when considered with the data on the effective tax rate in that country[3], The modelling work of Caragata and Giles (1998) and Giles and Caragata (1998) provides simulation evidence which sharpens our understanding of this linkage. Finally, when the ratio data in Figure 1 are decomposed into separate series[4] for hidden and recorded output, we find that the *absolute size* of the hidden economy exhibits greater volatility than does recorded real output - the sample coefficients of variation are 26% and 15% respectively.

III. ECONOMETRIC MODELLING AND THE HIDDEN ECONOMY

Because complete samples of values for the hidden economy are quite rare, it is difficult to find explicit examples of econometric models which incorporate this important facet of the economy. Recently, however, the data generated by Giles (1997a) have been used in several such ways. First, the time-series of data for the New Zealand hidden economy have been used to examine the causal linkages between this sector of the economy, and other interesting macroeconomic variables. For example, Giles (1997b) reports evidence of Granger causality from measured to hidden activity in New Zealand, but only weak evidence of causality in the reverse direction. This finding poses something of a dilemma for policy-makers wishing to stimulate economic growth, but also wishing to contain the "tax-gap". Johnson (1998) has extended this analysis by re-considering the money-output causality issue for New Zealand, with an explicit allowance for both recorded and hidden output. Interestingly, she finds causality from M3 to measured output, but no such causality when "hidden output" is added to the latter variable. This has important implications for monetary policy in that country.

The hidden output data have also been used by Giles (1997d, 1998a) to test for asymmetries in the measured and hidden business cycles. No asymmetries are found in either cycle, implying that fiscal and monetary policy changes that respond to the observed business cycle are likely to have consistent effects on the hidden cycle. Finally, (Giles, 1997c) I have found strong evidence of Granger causality from tax-related prosecutions to the size of the hidden economy in New Zealand, suggesting that the compliance efforts of that country's Inland Revenue Department are *pro-active*, rather than *reactive*. This is an important conclusion in relation to the allocation of resources to encourage taxation compliance.

Unrecorded economic activity is untaxed, implying a shortfall between actual and potential tax revenue. This "tax-gap", can be estimated by multiplying the hidden/measured GDP ratio by total tax revenue, giving figures which range from 6.4% to 10.2% of total tax liability over the sample, representing $0.07Billion to $3.18Billion in foregone nominal revenue[5]. Caragata and Giles (1998) and Giles and Caragata (1998) estimate a non-linear relationship between hidden output and the effective tax rate, with allowances for growth in real measured output and for changes in the "tax mix" over time. They then simulate the effect on the hidden economy of various changes in fiscal policy. Among their most important findings are first, that in New Zealand, approximately half of hidden activity is fiscally responsive - the rest being "hard core evasion"; second, that an effective tax rate of the order of 21% of GDP maximizes the impact of tax reductions on the hidden economy; and third, that adjusting fiscal policy in favour of more indirect taxation and less direct taxation is effective in combatting tax evasion. These results warrant further investigation in other economies.

IV. THE DEMAND FOR MONEY, AGAIN

To add to the above list of examples of econometric analyses using hidden economy data, I consider one further application. Here I provide some new results on modelling the demand for money in New Zealand, taking account of the fact that recorded output understates actual output. This under-statement varies over the business cycle. Consider the following simple money demand equation, which is in the spirit of early work by Laidler and Parkin (1970), and Hendry and Mizon (1978):

$$\mathbf{M_t = \beta_0' \, Y_{Rt}^{\beta_1} R_t^{\beta_2} P_t^{\beta_3} \exp(\epsilon_t)} \; , \tag{1}$$

where M_t is the money stock; Y_{Rt} is "recorded" real output or income; R_t is a short-term interest rate variable; and P_t is the price level, at time "t". Thomas (1985) provides an excellent discussion of the issues associated with the formulation and estimation of such money demand models, including the issues associated with the choice of data for the money, output, and interest rate variables. Taking natural logarithms (in lower-case symbols):

$$\mathbf{m_t = \beta_0 + \beta_1 y_{Rt} + \beta_2 r_t + \beta_3 p_t + \epsilon_t} \; , \tag{2}$$

where $\beta_0 = \log(\beta_0')$.

Suppose that we extend model (1) to allow for both a "recorded" and a "hidden" sector, with the demand for money depending on total output, $Y_{RHt} = (Y_{Rt} + Y_{Ht})$. The obvious counterpart to equation (2) is[6]:

$$\mathbf{m_t = \beta_0 + \beta_1 y_{RHt} + \beta_2 r_t + \beta_3 p_t + \epsilon_t} \; , \tag{3}$$

Clearly, one interesting question is whether or not such an allowance for the presence of hidden activity, if data for the latter are available, has any impact on the policy conclusions arising from the estimation of the money-demand model. I explore this here with the New Zealand hidden economy data described above. The sample covers the calendar years 1975 to 1994. The starting date is constrained by the available interest rate data, while the finishing date is determined by the estimated hidden output data. Here, M_t is M3, a choice governed by the fact that narrower definitions of the New Zealand money stock exhibit structural breaks over the sample period because of changes in the way in which EFTPOS transactions[7] were categorized. P_t is the Consumer Price Index, and R_t is the ninety-day bill rate. Both Y_{Rt} and Y_{Ht} are in real 1982/83 millions of dollars. Further data details are given by Giles (1997a), and are available on request.

Table 1 shows the results of testing the various (log) data series for non-stationarity. Both the "augmented" Dickey-Fuller (Said and Dickey, 1984) (ADF) and Kwiatowski *et al.* (1992) (KPSS) tests are used[8]. I have followed the sequential strategy suggested by Dolado *et al.* (1990) to deal with the drift and trend terms in the ADF regressions, In Table 1, t_{dt} is the ADF "t-test" with drift and trend; F_{ut} is the ADF "F-test" for a unit root and "zero trend"; t_d is the ADF "t-test" with drift (but no trend); F_{ud} is the ADF "F-test" for a unit root and "zero drift"; and t denotes the "no-drift/no-trend" ADF "t-test". Expository illustrations of the Dolado *et al.* strategy are given by Giles *et al.* (1992), and Giles (1997a), for example.

(*Table 1 About Here*)

The unit root test results in Table 1 suggest that each of the variables for equations (2) and (3) are I(1). This was supported when the corresponding tests were applied to the first-differenced data. The other results in Table 1 relate to the Engle-Granger "two-step" test for cointegration between the variables in each case. As we see, in each equation the variables appear to be cointegrated. It would be interesting to investigate this issue further, using Johansen's procedure to determine the *number* of cointegrating vectors, but here I shall simply use the evidence of *some* cointegration to support the estimation of (2) and (3) in the (log) *levels* of the data. That is, I will focus on long-run equilibrating relationships, rather than on short-run dynamics via error-correction models. Indeed, the issue of lags and dynamics in the context of money demand equations has been controversial (*e.g.*, Mayes, 1981, pp.171-177; Thomas, 1985, pp.322-326).

The OLS results for (2) and (3) appear in Table 2, with some basic diagnostic statistics. These were also obtained with SHAZAM (1997).)In that table, DW is the *exact* Durbin-Watson test; JB denotes the Jarque-Bera normality test; R_i is the RESET test using "i" powers of the conditional mean; F_i is the FRESET test (DeBenedictis and Giles, 1998) using "i" Fourier terms; LM_i is the Lagrange Multiplier test for "ith." order autocorrelation; and H denotes the Hausman test statistic[9], based on OLS and IV estimation (using lagged regressors as instruments). The results in Table 2 indicate that for both models, the estimated coefficients are of the anticipated sign and are significant, and the diagnostic tests support the models' specifications. No significant values were obtained for any of the homoskedasticity test statistics that are routinely computed by SHAZAM; the stability of the demand for money was supported by both CUSUM and CUSUMSQ tests; and application of the Davidson and MacKinnon (1981) "J test" produced "t-statistics" of -0.32 and 0.86, so neither of the two models could be rejected in favour of the other.

(*Table 2 About Here*)

The parameter estimates for equations (2) and (3) in Table 2 are quite similar, but there are some interesting differences. For example, adding in the hidden sector suggests this demand is income *inelastic*, rather than elastic. (Neither elasticity is *significantly* different from unity.) In contrast, the estimated price and interest rate elasticities *increase* slightly, and become more significant, when underground output is incorporated into the model. Generally, the New Zealand money demand function appears to be quite robust to the exclusion of the underground economy, and so orthodox models may be quite reliable for policy-making.

V. CONCLUSIONS

The very nature of the hidden economy makes one sceptical of any attempts to measure its magnitude, and to use such measures in econometric models designed to aid policy-makers. However, during the past three decades, statistical tools have been developed which make this task less daunting. Coupling this with the widespread international evidence that the hidden economy is large, growing, and at least partially sensitive to fiscal instruments in most countries, I would contend that careful attempts to estimate and use measures of the hidden economy should be taken seriously. Even basic evidence on the causal relationships between hidden output and other macroeconomic variables is important for policy-making; and if allowances for the hidden sector in our structural models affect the associated policy implications, then this deserves further research.

TABLE 1

Unit Root and Cointegration Tests

Money Demand Models: Annual Logarithmic Data

Sample period: 1975 - 1994

	ADF Non-Stationarity Tests							KPSS Stationarity Tests (l = 8)		
Series	**p**	t_{dt}	F_{ut}	t_d	F_{ud}	**t**	**I(?)**	**Level**	**Trend**	**I(?)**
m	0	-2.37	2.82	-0.52	4.87*	n.a..	**I(1)**	0.38*	0.17*	**I(1)**
y_{RH}	0	-1.65	2.25	0.66	3.71	2.6	**I(1)**	0.30	0.20*	**I(1)**
y_R	0	-1.87	2.77	0.74	4.31*	n.a..	**I(1)**	0.19	0.21*	**I(1)**
r	0	-2.13	3.08	-1.94	1.90	-0.12	**I(1)**	0.10	0.16*	**I(1)**
p	1	2.15	2.53	-2.27	3.31	0.84	**I(1)**	0.22	0.16*	**I(1)**

Engle-Granger/ADF Cointegration Tests

Equation	**No Trend**	**With Trend**
(2)	-4.04*	-4.04
(3)	-3.93*	-3.94

***** : Significant at the 10% level

TABLE 2

OLS Regression Results[1,2,3]

Eqn.	β_0	β_1	β_2	β_3	R^2	DW	H
(2)	-14.175	1.142	-0.052	0.261	0.98	1.90	0.47
	(-4.665)	(3.561)	(-1.848)	(4.820)		[0.18]	[0.92]
(3)	-12.617	0.973	-0.058	0.281	0.97	1.84	1.00
	(-4.622)	(3.394)	(-2.050)	(5.514)		[0.14]	[0.80]

Further Diagnostic Tests

Eqn.	JB	R_2	R_3	R_4	F_2	F_4	F_6	LM_1	LM_2	LM_3	LM_4
(2)	1.27	0.00	0.92	0.63	1.45	2.01	1.63	0.14	0.39	1.24	1.81
	[0.53]	[0.99]	[0.42]	[0.61]	[0.27]	[0.16]	[0.24]	[0.89]	[0.70]	[0.21]	[0.07]
(3)	0.94	0.04	1.01	0.66	1.28	2.00	1.40	0.28	0.51	1.23	1.77
	[0.63]	[0.84]	[0.39]	[0.59]	[0.31]	[0.16]	[0.30]	[0.78]	[0.61]	[0.22]	[0.08]

1. "t-values" appear in parentheses.

2. "p-values" appear in brackets.

3. Although we expect $\beta_0' > 0$, the anticipated sign of β_0 is ambiguous.

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FOOTNOTES

* I am grateful to Johannah Branson, Patrick Caragata, Linda DeBenedictis, Erwin Diewert, Judith Giles, Anna Heiler, Betty Johnson, Knox Lovell, Gerald Scully, John Small, Adolf Stroombergen, Lindsay Tedds, and Ken White for their constructive suggestions on the research underlying this paper. None of them should be blamed for any excesses in the views expressed here. Full details of my research program on the hidden economy, and copies of all of my papers on this topic, can be downloaded from my internet site at the following address: **http://web.uvic.ca/econ/economet_he.html**.

1. Changes in the relative size of the hidden economy and in (tax revenue/GDP) over time, are illustrated at **http://web.uvic.ca/econ/figure1.gif** and **http://web.uvic.ca/econ/figure3.gif** respectively, on the internet.

2. See Zellner (1970), Jöreskog and Goldberger (1975), and Jöreskog and Sörbom (1993).

3. Near the end of my sample, (Tax Revenue/GDP) was at a 100 year high in New Zealand. See **http://web.uvic.ca/econ/figure5.gif** on the internet.

4. For details, see **http://web.uvic.ca/econ/figure8.gif** on the internet.

5. See **http://web.uvic.ca/econ/figure9.gif** on the internet.

6. Clearly, the model could be extended to allow for different elasticities with respect to recorded and hidden output. Indeed, the *currency* demand equation used in Giles (1997a) to calibrate the MIMIC model index makes just such an allowance.

7. "EFTPOS" denotes "Electronic Fund Transfer at Point of Sale", and refers to the introduction of the use of bank debit card for electronic retail transactions in lieu of cash in June 1987.

8. In the former case the null is a unit root and the alternative is stationarity. In the latter case the null is either level or trend stationarity, and the alternative is a unit root. For the ADF tests, the augmentation level (p) is chosen by the default method in SHAZAM (1997). This method is supported by the results of Dods and Giles (1995), in terms of minimal size-distortion, for samples of our size.

9. The null hypothesis that the regressors are uncorrelated with the errors is strongly supported, and not surprisingly the OLS and (unreported) IV parameter estimates are very similar.

Figure 1

The N. Z. Hidden Economy (% of GDP)