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MEASURING THE HIDDEN ECONOMY: IMPLICATIONS FOR ECONOMETRIC MODELLING*

David E. A. Giles

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 include 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, 1997*a*). 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. This is an area that has been largely neglected until now.

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 can consult the discussion and references in Giles (1997*a*), Caragata (1998), Caragata and Giles (1998), and Giles and Caragata (1998), for ex-

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[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 web.

ample. These stylised facts point to the importance of allowing for the underground economy in the construction of economic models.

1. Methods for Measuring the Hidden Economy

There is a large literature on measuring the size of the hidden economy. Some of the approaches that have been used are discussed by Erard (1997), Giles (1997*a*), and others. These approaches include using surveys of taxation compliance; using the 'initial discrepancy' between national income and national expenditure, and associated judgmental methods; considering fluctuations in labour force participation rates; the 'currency ratio approach' of Cagan (1958) and others; the monetary 'transactions approach' of Feige (1979); and the use of 'latent variable' structural models. Most of these methods have weaknesses, which are well documented, but are worth summarising here.

Surveys of tax compliance generally underestimate the size of the underground economy because respondents are unwilling to admit to the true extent of their participation in illegal activities. There are also important issues relating to questionnaire design that are not always attended to adequately. National accounts/judgmental methods involve no formal 'modelling' of the underground economy, but instead rest on a detailed breakdown of either the expenditure or income side of the national accounts into its component parts, and the application of subjective judgements as to the maximum likely levels of unrecorded incomes or expenditures. The weaknesses of this approach are first, its subjectivity, and second the narrowness of its coverage. Specifically, it takes a GDP perspective, rather than a tax-base perspective of hidden activity. Accordingly, the resulting estimates of the underground economy are also likely to be quite conservative. A similar 'bias' arises with measures based on variations (over time or across countries) in labour force participation rate data, due to the narrow focus of such data, and the likelihood of other economic and socio-demographic sources of such changes.

The weakness of the basic currency ratio method of Cagan (1958) arises from its three primary assumptions: all unreported transactions are in the form of currency (cash); the ratio of cash to demand deposits is constant over time in the measured economy; and the income velocities of currency are the same in both the measured and informal sectors. The second of these assumptions is especially troublesome with the advent of electronic banking transactions. Results based on the crude currency ratio method are suspect, and they tend to be sensitive to data definitions (e.g., with regard to the breadth of the money supply).

Tanzi's (1983) methodology relaxes the assumption of a constant ratio of cash to the money supply by making this ratio a function of the rate of interest, *per capita* income, various tax variables, and the share of wages in national income. Although this is an improvement over the crude 'currency ratio' approach, it still suffers from the unrealistic assumptions that all underground transactions are undertaken with cash, and that they are all motivated by a desire to avoid taxes. Moreover, it relies on the presumption that there is a stable relationship between the currency to money supply ratio and the various variables noted above, and that the form of this function is known. So, Tanzi's method also rests on several questionable assumptions, and is prone to mis-specification biases which often lead to an over-estimation of the size of the underground economy (Erard, 1997, p. 14).

Bhattacharyya (1990) has proposed a different variation of the currency ratio approach in his study of the British underground economy. He estimates a novel currency demand equation which distinguishes between, and separates, measured and hidden output as explanatory variables, and incorporates a 'proxy' for the latter. His approach has several merits, including the potential for testing theories of tax evasion properly, but it involves a functional approximation and it concentrates on only one direct 'signal' of hidden activity, namely the demand for currency.

Feige's (1979) 'transactions method' avoids most of the problems associated with the rather strong assumptions associated with the above approaches. However, it has the disadvantage of requiring a considerable amount of data information in order to properly estimate turnover rates for currency, and to eliminate financial transactions from gross payments. In practice, this can severely limit the reliability of this approach to measuring the underground economy.

Of the various methods that have been used to measure the underground economy, latent variable/MIMIC modelling is the most modern and the most comprehensive. A MIMIC ('Multiple Indicators, Multiple Causes') model is a structural econometric model, which treats the size of the underground economy as an unobservable 'latent' variable. The latter is linked on the one hand to a collection of (observable) indicators which 'reflect' changes in the size of the underground economy; and on the other hand to a set of (observed) causal variables which are believed to be important driving forces behind underground economic activity. MIMIC models have been applied to a wide range of problems in many disciplines since they were first introduced by Zellner (1970). Although there have been only a few applications of this approach to the problem of measuring the underground economy, the MIMIC model is becoming viewed as a powerful approach to this problem, as it allows for several different explanatory factors and several indicators of hidden activity simultaneously.

Frey and Weck-Hannemann (1984) pioneered the use of MIMIC modelling in the context of the underground economy with their international comparative study; Aigner *et al.* (1986) estimated a dynamic MIMIC model for the U.S. hidden economy; Schneider (1997) has applied this methodology to a number of countries recently; and Giles (1997*a*) and Tedds (1998) have used this approach to measure the New Zealand and Canadian underground economies, respectively. Being based on time-series data, MIMIC models are prone to the same risks associated with data non-stationarity as are other regression models, if such non-stationarity is not detected and handled appropriately (e.g., Giles, 1997*a* and Tedds, 1998). I find the use of such structural latent variable models to be encouraging, partly because they take explicit account of *both* indicators of hidden activity, and potential causes, in an explicit structural model, and also because this framework facilitates formal statistical testing of these relationships.

2. 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 (1997*a*), but basically I estimated a comprehensive MIMIC model[2] to get a time-series index of hidden/measured output, and estimated a separate 'cash-demand' model to obtain a benchmark for converting this index into percentage units. Unlike earlier empirical studies of the hidden economy, proper attention was paid to the non-stationarity, and possible cointegration of the time-series data in both models.

My MIMIC model treats hidden output as a '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 that of Bhattacharyya (1990): I allow for different velocities of circulation in the 'hidden' and 'recorded' economies, and avoid a functional approximation in his approach. My cash-demand equation is *not* used as an input to determine the variation in the hidden economy over time – it is used only to obtain the long-run average value of hidden/measured output, so that the index for this ratio predicted by the MIMIC model can be given a level and expressed in percentage units.

Fig. 1 shows my time-series of the New Zealand hidden economy, as a percentage of real GDP, over the period 1968 to 1994. Evidence in support of its recent order of magnitude is generated from actual Inland Revenue Department audit records by Giles (1998*c*). 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 (1997*d*, 1998*a*). 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. Fig. 1 corroborates this for New Zealand,

[2] See Jöreskog and Goldberger (1975), and Jöreskog and Sörbom (1993) for details on the estimation of MIMIC models.

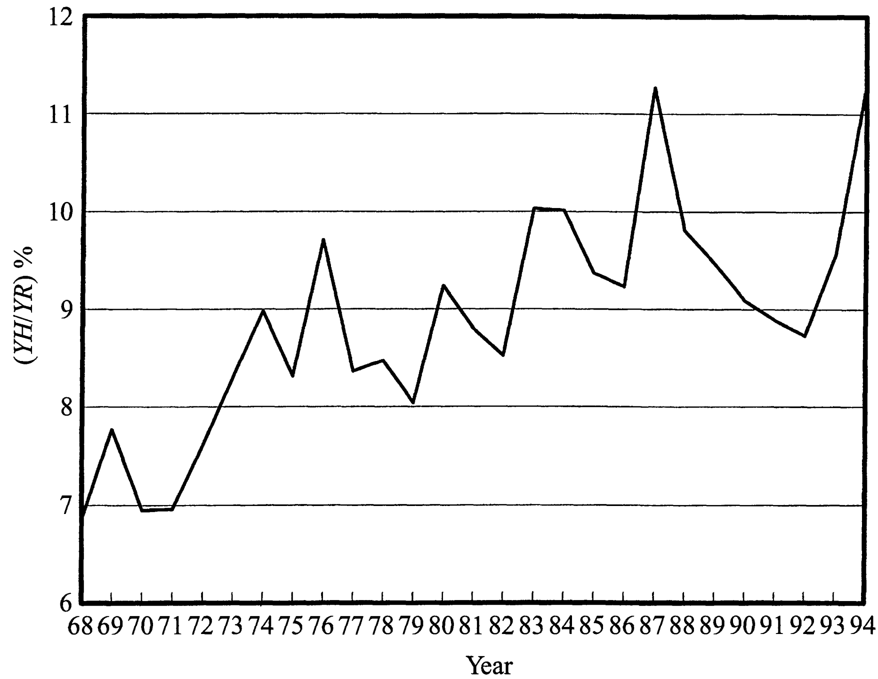

Fig. 1. *The N.Z. Hidden Economy (% of GDP)*

especially when considered with the data on the effective tax rate in that country,[3] and Caragata and Giles (1998) and Giles and Caragata (1998) provide simulation evidence which sharpens our understanding of this linkage. Finally, when the ratio data in Fig. 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.

3. Econometric Modelling and the Hidden Economy

Because complete samples of values for the hidden economy are unusual, 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 (1997*a*) 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 (1997*b*) 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

[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 web.

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

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 – it may not be as effective overall as the measured data suggest.

The hidden output data have also been used by Giles (1997*d*, 1998*a*) 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, 1997*c*) 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 $0.07bn to $3.18bn 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 maximises 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 combating tax evasion. These results warrant further investigation in other economies. For example, their implications are interesting in the Australian context, given that country's recent decision to introduce a GST.

4. The Demand for Money, Again

To add to the above examples of econometric analyses using hidden economy data, I consider one further application here, and 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 equa-

[5] See http://web.uvic.ca/econ/figure9.gif on the web.

tion, which is in the spirit of early work by Laidler and Parkin (1970), and Hendry and Mizon (1978), and has its roots in the 'optimum cash balance' theory of Baumol and Tobin (1989):

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

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):

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

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,[6] $Y_{RHt} = (Y_{Rt} + Y_{Ht})$. One obvious counterpart to (2) is:[7]

$$m_t = \beta_0 + \beta_1 y_{RHt} + \beta_2 r_t + \beta_3 p_t + \varepsilon_t. \tag{3}$$

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[8] were categorised. 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 1982/3 millions of dollars. Further data details are given by Giles (1997*a*), and are available on request.

The within-sample coefficient of variation for the velocity of circulation of M3 is 17.2% in terms of measured (nominal) output, but only 14.9% in terms of hidden (nominal) output. These nonzero values do *not* support the crude quantity theory of money. Moreover, the fact that they are significantly different from each other, conflicts with a basic premise of Cagan's 'currency ratio'

[6] A cash-demand model was used to 'calibrate' the hidden output index generated by my estimated MIMIC model. However, the latter model does *not* have cash or any other components of M3 as explanatory variables, and so the *variation* in the hidden economy series is not 'explained' by such variables. The cash-demand equation serves merely to generate a long-run average *level* for the hidden/measured output ratio.

[7] Clearly, the model could also be specified with hidden and measured outputs as separate regressors, thereby allowing for different associated elasticities. This is taken up in the discussion of the results below.

[8] '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.

approach to measuring the hidden economy and lends support to our methodology.

The (log) data series were tested for non-stationarity, using both the 'augmented' Dickey-Fuller (ADF) and Kwiatowski *et al.* (1992) (KPSS) tests. All of the variables for (2) and (3) are I(1). Application of the Engle-Granger 'two-step' test for cointegration indicated that in each equation the variables appear to be cointegrated,[9] and this supports 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. 171–7; Thomas, 1985, pp. 322–6).

The estimation results appear in Table 1. In addition, (3) was re-specified and estimated with y_{Rt} and y_{Ht} as separate regressors. The latter was statistically insignificant (t = 0.333), but a test of the restriction that these regressors have equal coefficients could not be rejected (t = 0.057). Accordingly, the results associated with (3) appear in favour of these results in Table 1, with some basic diagnostic statistics, obtained with the SHAZAM (1997) package. DW denotes 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,[10] based on OLS and IV estimation (using lagged regressors as instruments). The results in Table 1 indicate that for both models, the estimated coefficients are of the anticipated sign and are significant, and the

Table 1
OLS Regression Results

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]

Notes: 't-values' appear in parentheses.
'p-values' appear in brackets.
Although we expect $\beta_0' > 0$, the anticipated sign of β_0 is ambiguous.

9 A table of results for the unit root and cointegration tests is given by Giles (1998*d*).
10 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.

diagnostic tests support the models' specifications. No significant values were obtained for any of the homoscedasticity 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.

The parameter estimates for (2) and (3) in Table 1 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. To the extent that these money demand functions are based on the 'optimum cash balance' theory, income and price elasticities of 0.5 would be expected. Testing these hypotheses yields p-values of 0.062 and 0.0004 respectively for the t-tests in the case of equation (2), and 0.118 and 0.001 respectively for (3). So, if the underground economy is ignored, the model is much less supportive of the 'optimal cash balance theory' than if hidden activity is taken into account. Generally, though, 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 in this particular case.

5. 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 given higher priority. Even basic evidence on the causal relationships between hidden output and other macroeconomic variables is important for policy-making. Moreover, if the policy conclusions arising from our structural econometric models, or our macroeconomic forecasts, are sensitive to whether or not we take account of the underground economy, then this has serious implications. Much more research into these issues is needed.

University of Victoria, Canada

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