The Canadian Underground and Measured Economies: Granger Causality Results

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University of Victoria

2002

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June, 1999
(*References updated, March 2002*)

Abstract

Using new time-series data for the size of the Canadian underground economy, we examine the relationship between unreported and measured GDP in that country. Granger causality tests are conducted, with a proper allowance for the non-stationarity of the data. We find that there is clear evidence of such causality from measured GDP to "hidden" output, but only very mild evidence of Granger causality in the reverse direction. This result supports similar evidence for New Zealand reported by the first author, and has several interesting policy implications.

JEL classification: C53, H26

Keywords: Underground economy; Granger causality; business cycles

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I. INTRODUCTION

Recently, there has been a significant resurgence of interest in the underground economy in various countries. This has been driven in part by the recognition that the size of the underground economy is growing in both absolute and relative terms internationally. There is now comprehensive evidence that the hidden economy, expressed as a percentage of measured GDP for comparative purposes, has been growing quite steadily over the past two or three decades in virtually every country that has been studied. For example, Schneider and Enste (2000) document this phenomenon for sixty-seven countries. A very detailed analysis of this situation in New Zealand is discussed by Giles (1997a, 1997b, 1999a, 1999b, 1999c); and similar evidence for Canada is provided by Giles and Tedds (2002).

The growth in the underground economy and tax evasion can been explained by the corresponding increase in effective tax rates in many countries, rising regulatory activity in certain jurisdictions, and a general decline in ethical standards (*e.g.*, Caragata and Giles 2000; Giles and Caragata, 2001; Schneider and Enste, 2000). Demographic trends and an increase in the number of home-based businesses are also important factors in countries such as Canada.

In this context it is interesting to investigate the nature of the relationship between unreported and measured output. A rise in the relative size of the underground economy (*i.e.*, in the ratio of hidden to measured GDP) is the net result of the underground economy growing at a faster rate than GDP. This raises important policy questions, such as: to what extent is the flight underground retarding measured economic growth? What is the connection between the measured and unmeasured business cycles? Giles (1997a, 1997b, 1999a) has previously addressed these questions in relation to the New Zealand underground economy.

In this paper we use new time-series data on the Canadian underground economy compiled by Giles and Tedds (2002) to examine the causal relationship between the underground and reported economies in that country. The results reported below provide strong support for the conclusions reached by Giles (1997a).

II. DATA ISSUES

Following earlier work by Tedds (1998), recent research by Giles and Tedds (2002) has used MIMIC modelling[1] to generate annual values for the relative size of the Canadian underground economy for the period 1976 to 1995. These appear in Figure 1. The series[2] ranges in value from approximately 3.5% of measured GDP in 1976 to around 16% in 1995. The latter figure accords well with the results of Schneider and Enste (2000). Using a different approach to ours, they obtain a figure of about 15% of GDP in the mid-1990's. Using the actual real measured GDP data for Canada over this period[3] we can then obtain a corresponding real dollar series for the underground economy (UE), which ranges from about C$13Billion in 1976 to about C$96Billion in 1995, in constant 1986 dollar terms[4]. Visually, the data for measured and underground real output each appear non-stationary, so care has to be taken when testing for Granger causality between them.

[Figure 1 About Here]

In order to apply our chosen procedure for testing for Granger causality, namely that suggested by Toda and Yamamoto (1995), we need to determine the *maximum* order of integration of each of the series being studied. To do this we have used[5] the standard "augmented" Dickey-Fuller (ADF) test (*e.g.*, Dickey and Fuller, 1979, 1981; Said and Dickey, 1984). Dods and Giles (1995) show that the default method of obtaining the augmentation level, p, in the SHAZAM (1997) package is a good choice for samples of our size if one wishes to avoid a finite-sample size-distortion in the implementation of these tests. With respect to the inclusion of drift and/or trend terms in the ADF regression, we follow the sequential strategy of Dolado *et al.* (1990), which is also used in this context by Giles (1997a). To test that the series x_t is I(1), against the alternative that x_t is I(0) (or stationary) the level of augmentation, p, is determined as above, in the context of the following full ADF regression:

$$\Delta x_t = \alpha + \beta t + \gamma x_{t-1} + \theta_1 \Delta x_{t-1} + \ldots\ldots + \theta_p \Delta x_{t-p} + \varepsilon_t \quad . \qquad (1)$$

We test H_o: $\gamma = 0$ *vs.* H_A: $\gamma < 0$ using the Dickey-Fuller "t" test (denoted "t_{dt}" below) and MacKinnon's (1991) critical values. If H_0 is rejected, we conclude that x_t is stationary, otherwise we test H_0: $\beta = \gamma = 0$, using the "F-test" (denoted "F_{ut}" below) of Dickey and Fuller (1981). A rejection implies that x_t is I(1); otherwise we remove the trend from (1) and test H_0: $\gamma = 0$ *vs.* H_A:

$\gamma < 0$. The ADF "t-statistic" is denoted "t_d". If we cannot reject H_0, we test H_0: $\alpha = \gamma = 0$ using the "F-test" (denoted "F_{ud}" below) of Dickey and Fuller (1981). A rejection implies that x_t is I(1); otherwise we remove the drift term and re-estimate (1), and test H_0: $\gamma = 0$ *vs.* H_A: $\gamma < 0$. This "t-statistic" is denoted "t" in Table 1. A rejection suggests that x_t is I(0), while failing to reject suggests that x_t is I(1).

As some economic time-series are I(2), we test I(3) against I(2) (applying the above analysis to the doubly-first-differenced data); then if we reject I(3) we test I(2) against I(1) (using the first-differences of the data), and we finally test I(1) against I(0), if necessary (following Dickey and Pantula, 1987). The results of this analysis appear[6] in Table 1, where we see that real GDP is I(1), but we cannot reject the hypothesis that UE is I(2). This is an interesting result, and is contrary to Giles' (1997a) finding for New Zealand. Its economic implications are discussed below in Section IV.

[Table 1 About Here]

II. MODEL ESTIMATION AND GRANGER CAUSALITY

We have used a two-equation VAR model, and the methodology of Toda and Yamamoto (1995) to identify the direction(s) of any causality between GDP and UE. Care must be taken in the way that this testing is performed if the usual test statistics are to have standard asymptotic distributions in the presence of non-stationary data such as ours. Toda and Yamamoto (1995) show that this standard asymptotic theory holds if we determine the lags in the VAR equations in the usual way, but then we add extra lags of the variables, equal in number to the maximum suspected order of integration. In our case, this means adding *two more* lags of each variable in each equation. We then estimate the system, and we can apply the usual Wald test to see if the coefficients of the lagged UE variables (*excluding the extra ones*) are jointly zero in the GDP equation. Similarly, we test if the coefficients of the lagged GDP variables (*excluding the extra ones*) are jointly zero in the UE equation. In each case, the Wald test statistic will be asymptotically Chi Square, with degrees of freedom equal to the number of "zero restrictions", *even though GDP and UE are non-stationary.*

[Table 2 About Here]

Using the Schwartz Criterion and Akaiake's Information Criterion to determine the lag lengths, we have constructed two-equation VAR models for the following three cases: no constant and no trend; constant but no trend; and constant and linear trend. The results of estimating these models by maximum likelihood, using the SHAZAM (1997) package, appear in Table 2. We see there that the Breusch-Pagan Lagrange Multiplier test supports our use of systems estimation, rather than single-equation estimation. The positive coefficients on the lagged GDP variables in the UE equation suggest that increases (decreases) in the measured economy induce variations of a *similar sign* in the underground economy. Similarly, the negative coefficients on the lagged UE variables in the GDP equation suggest that increases (decreases) in the underground economy induce variations of the *opposite sign* in the measured economy. The economic implications of this are explored in Section IV below.

Of course, this presupposes the existence of causality between these variables. The results of applying the Wald tests for Granger *non-causality* to the "augmented" VAR models appear in Table 3, together with various diagnostic tests, suitably modified to allow for their application in the context of a jointly-estimated system[7]. All of these tests have only asymptotic justification, so we used "bootstrap" simulation, with 5,000 replications, to obtain their *exact* p-values. These are also reported in Table 3, and on this basis the diagnostic tests suggest that the VAR models on which the Wald-testing is based are quite well specified. We also see there is strong evidence of *causality* from GDP to UE. (We clearly *reject non-causality* in this direction.) There is only very mild evidence that the causality is bi-directional. (Only in the constant/trend model do we *reject* the *absence* of causality from UE to GDP at the 10% significance level, but not at the 5% or 1% levels.)

[Table 3 About Here]

III. Economic Implications

These causality results accord entirely with those of Giles (1997a) for the New Zealand underground and measured economies. The clear evidence of causality from measured to hidden output poses an interesting dilemma for policy-makers. If expansionary monetary or fiscal policies are used to stimulate measured output, then it seems that this will also have a subsequent effect on the size of the underground economy. The positive coefficients on the lagged GDP variables in the UE equations in our VAR models reported in Table 2 imply that this effect will also be an expansionary one. That is, *both* the measured and hidden economies will be stimulated in the same direction. It then remains to determine whether the *relative* size of the underground economy, (UE/GDP), will increase or decrease.

Taking up this last point, the results of Caragata and Giles (2000) and Giles and Caragata (2001) for New Zealand show clearly that an expansionary fiscal policy (through a reduction in the effective tax rate) will lead to a *reduction* in (UE/GDP), *ceteris paribus.* Giles and Tedds (2002) show that the same is true in the Canadian case. In essence, the size of the hidden economy shrinks, and measured GDP increases. The latter arises partly because of the direct stimulation of this fiscal policy, and partly because previously at least some unmeasured output is now measured. In fact government revenue can also rise (notwithstanding the tax-cut), given the increase in the tax-base. The propensity for this to occur depends, of course, on the magnitude of the cut, and the initial effective tax rate.

To the best of our knowledge, there is virtually no corresponding empirical evidence available regarding the relationship between monetary policy changes and the relative size of the underground economy[8]. The analysis of Langfeldt (1985) suggests that changes in the money supply appear to have little direct effect on the hidden economy. However, as in several other countries, monetary policy in Canada is now directed towards maintaining inflation within a narrow band, and there is empirical evidence (*e.g.*, Frey and Weck-Hannemann, 1984; Giles, 1999c; Tedds, 1998) that inflation is a causal factor of underground activity. So, one would anticipate an indirect link between monetary policy changes and unrecorded output.

The apparent absence of any significant causality *from* the underground economy *to* measured output is also interesting from a policy perspective. The negative coefficients on the lagged UE variables in the GDP equations, as reported in Table 2, suggest that an increase in the hidden economy may have a negative impact on measured economic growth. However, these coefficient estimates are generally insignificant. The absence of causality is consistent with the observed concurrent growth of both of these sectors in Canada in recent years. It also suggests that policy changes such as more stringent penalties for tax evasion, intended to combat the growth of the underground economy, will not necessarily by themselves stimulate measured output. This is a serious issue in the Canadian context, especially given the fact that recent attempts by Revenue Canada's "Underground Economy Initiative" to increase compliance enforcement apparently has met with limited success [9].

Finally, the results of the unit root testing in Table 1 imply that the Canadian underground and measured economies *cannot be* cointegrated as the series are integrated of different orders[10]. That is, in the face of a shock to one of these series, there is no linear long-run equilibrating mechanism that will prevent these two economic variables from moving further and further apart over time. From a policy perspective, this has serious implications. For example, in the context of the recent and present "tax revolt" in that country, this means that any adverse growth effects arising from the increased tendency of agents to "go underground" are unlikely to be short-lived, unless direct policy actions (such as a reduction in the tax burden) are taken.

IV. SUMMARY & CONCLUSIONS

In this paper we have used new time-series data for the Canadian underground economy to explore some of the basic linkages between measured and hidden output in that country from the mid 1970's to the mid 1990's. Many of our results are strikingly similar to those that are available for the New Zealand underground economy. We find that there is no evidence of a long-run equilibrating mechanism linking the measured and unrecorded sectors, but that there is strong evidence of Granger causality from the former to the latter. There is only slight evidence of reverse causality.

Fiscal and monetary shocks will impact on both measured and underground output, and the net effect on the *relative size* of the underground sector is ambiguous, *a priori.* Other work by the authors (Giles and Tedds, 2002) addresses the relationship between changes in the effective tax rate and the relative size of the Canadian underground economy. A clear positive such relationship is identified. The linkages between monetary policy and the underground economy remain to be explored empirically in the Canadian context.

ACKNOWLEDGEMENTS

This research was funded by a grant from the Canadian Tax Foundation. The results and views expressed in this paper are those of the authors, and should not be attributed to their employers or to the Canadian Tax Foundation.

Table 1. *ADF unit root test results* [a]

		T	p	t_{dt}	F_{ut}	t_d	F_{ud}	t	Outcome
					GDP				
H_0 :	I(2)	18	0	-2.78	3.87	-2.87	4.11	n.a.	Reject I(2)
[H_A :	I(1)]								
H_0 :	I(1)	19	0	-1.64	1.38	-0.56	11.31	n.a.	I(1)
[H_A :	I(0)]								
					UE				
H_0 :	I(2)	15	3	-1.03	1.42	-1.64	1.40	-0.22	I(2)
[H_A :	I(1)]								
H_0 :	I(1)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
[H_A :	I(0)]								

Note: [a] T is the sample size; the other notation is defined in the text.

Table 2. ***Estimation of the basic VAR Models*** [a, b]

	No Constant, No Trend		Constant, No Trend		Constant, Trend	
			GDP Equation			
Constant	n.a.	(n.a.)	3884	(0.04)	$-3*10^7$	(-4.08)
Trend	n.a.	(n.a.)	n.a.	(n.a.)	13660	(4.51)
GDP_{-1}	1.037	(56.15)	1.028	(3.71)	1.024	(5.40)
UE_{-1}	-0.001	(-0.78)	-0.003	(-0.22)	-0.020	(-1.82)
UE_{-2}	n.a.	(n.a.)	0.002	(0.21)	-0.006	(-0.78)
R^2	0.962		0.962		0.983	
			UE Equation			
Constant	n.a.	(n.a.)	$-4*10^6$	(-1.86)	$-5*10^8$	(-3.35)
Trend	n.a.	(n.a.)	n.a.	(n.a.)	268640	(3.33)
UE_{-1}	0.970	(24.34)	0.697	(4.58)	0.173	(0.80)
GDP_{-1}	1.276	(2.78)	10.247	(1.73)	12.943	(2.72)
GDP_{-2}	n.a.	(n.a.)	2.526	(0.49)	1.000	(0.20)
R^2	0.986		0.988		0.993	
BP-LM [c]	7.50		8.08		3.79	
[p-value]	[0.006]		[0.002]		[0.052]	

Note: [a] These are the chosen specifications *before* the extra lags are added for the Toda-Yamamoto causality-testing procedure.

[b] Asymptotic "t-values" appear in parentheses.

[c] BP-LM is the Breusch-Pagan Lagrange Multiplier test for a diagonal error covariance matrix. (The test statistic is asymptotically χ^2_1 in a 2-equation system.)

Table 3. ***Causality tests, and diagnostics for the "augmented" models*** [a, b]

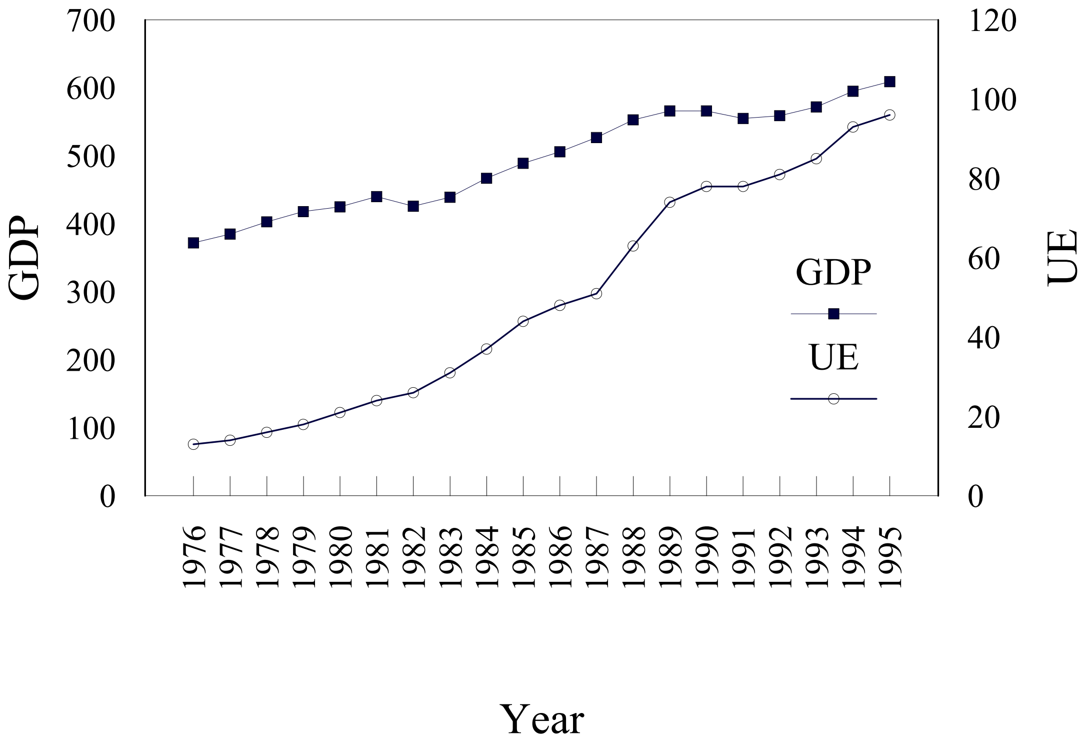
Equation	Wald[c]	JB (χ^2_2)	LM1 (χ^2_1)	LM2 (χ^2_1)	LM3 (χ^2_1)	LM4 (χ^2_1)	F1 (χ^2_2)	F2 (χ^2_4)	F3 (χ^2_6)
				No Constant, No Trend					
GDP	0.04	6.15	0.15	0.47	0.52	0.30	3.39	10.33	40.67
	(0.83)	(0.05)	(0.44)	(0.32)	(0.31)	(0.38)	(0.18)	(0.04)	(0.00)
	[0.84]	[0.14]	[0.92]	[0.71]	[0.62]	[0.82]	[0.52]	[0.53]	[0.36]
UE	0.12	2.15	0.16	0.16	0.97	0.56	2.74	10.83	187.45
	(0.74)	(0.34)	(0.44)	(0.43)	(0.17)	(0.29)	(0.25)	(0.03)	(0.00)
	[0.74]	[0.22]	[0.92]	[0.92]	[0.28]	[0.59]	[0.59]	[0.53]	[0.04]
				Constant, No Trend					
GDP	1.08	2.89	0.40	0.49	0.61	0.07	6.88	12.73	63.72
	(0.58)	(0.24)	(0.34)	(0.31)	(0.27)	(0.47)	(0.01)	(0.01)	(0.00)
	[0.35]	[0.06]	[0.73]	[0.67]	[0.56]	[0.96]	[0.39]	[0.62]	[0.50]
UE	13.24	0.21	0.86	0.09	0.71	0.34	24.04	41.28	931.76
	(0.00)	(0.90)	(0.20)	(0.46)	(0.24)	(0.37)	(0.00)	(0.00)	(0.00)
	[0.01]	[0.19]	[0.37]	[0.95]	[0.48]	[0.77]	[0.08]	[0.21]	[0.05]
				Constant, Trend					
GDP	5.32	11.24	0.82	1.61	0.15	1.04	5.36	30.61	30339.5
	(0.07)	(0.00)	(0.21)	(0.05)	(0.44)	(0.15)	(0.06)	(0.00)	(0.00)
	[0.07]	[0.08]	[0.34]	[0.06]	[0.91]	[0.20]	[0.53]	[0.41]	[0.03]
UE	15.14	0.63	1.20	1.18	0.38	1.24	9.37	22.12	116.65
	(0.00)	(0.73)	(0.12)	(0.12)	(0.35)	(0.11)	(0.01)	(0.00)	(0.00)
	[0.01]	[0.73]	[0.16]	[0.17]	[0.73]	[0.14]	[0.38]	[0.55]	[0.56]

Note: [a] Asymptotic p-values appear in parentheses, and bootstapped finite-sample p-values appear in brackets, below the test statistic values.

[b] The diagnostic tests relate to the VAR with the extra lagged variables added for the Toda-Yamamoto causality-testing procedure.

[c] The Wald causality test statistic is asymptotically χ^2_1 in the no drift/no trend case, and asymptotically χ^2_2 in the other two cases.

Figure 1
Canadian Measured and Underground Outputs
(Real 1986 C$Billions)



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Footnotes

1. "MIMIC" denotes "Multiple Indicator, Multiple Causes". This type of structural modelling has been popularized in the social sciences by Jöreskog and Sörbom (1993), and it has also been used to model the underground economy by other authors such as Frey and Weck-Hannemann (1984), Aigner *et al*. (1986), Loayza (1996), Schneider and Enste (2000), and Giles (1999c).

2. The data are available from the authors on request.

3. We have used annual series D14442 from the Statistics Canada CANSIM database.

4. This equates to a Canadian underground economy of about $130Billion in 1995 in *current-dollar* terms

5. The conclusions reached here are not altered if the tests of Kwiatowski *et al*. (1992) are used instead.

6. To conserve space we have omitted results relating to the tests of I(3) against I(2) as they had no bearing on our conclusions.

7. JB denotes the Jarque-Bera normality test; LM1 to LM4 are Lagrange Multiplier tests for serial independence against *simple* AR or MA alternatives; F1 to F3 are asymptotic Wald versions of the DeBenedictis and Giles (1998) FRESET test, using one to three sine and cosine functions of the predicted dependent variable in their construction. All of these tests have only asymptotic validity here, as lagged dependent variables appear as regressors.

8. However, see Giles (1999b) for a discussion of the role of hidden income in the formulation of money-demand functions.

9. The latest Report of the Auditor General of Canada (1999, Chap. 2) takes issue not only with the "return" that has been achieved on the resources allocated to the Underground Economy Initiative in recent years, but also on the way this return has been reported by Revenue Canada.

10. Unit root tests have notoriously low power, so there a possibility that UE is really I(1) rather than I(2), and then the potential for cointegration exists. However, pursuing this possibility, we found that there was *no evidence* of cointegration using the standard Engle-Granger (1987) two-step approach. CRADF statistic values of –2.274 (–1.855) were obtained based on cointegrating regressions without (with a linear trend).