Using Electricity Demand to Estimate State-Level Underground Economic Activity in the US

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Abstract

This paper estimates underground economic activity in the US at the state-level from 1998–2010. Previous studies rely on direct methods for estimating underground economies, such as surveys or audits, or indirect methods such as money demand. These methods have serious drawbacks in that they either systematically underestimate underground economic activity or are prone to substantial error. The physical input approach is a potentially more accurate way of measuring underground activity that has received little attention in the literature. This paper reports on an innovative application of the physical input method – electricity demand – to establish a state ranking of underground economic activity and to estimate state and US underground economy.

*JELcodes:*H2, H5, H7, Q4, R1

Key Words: Underground economy, Electricity demand, Physical Input Method

I. Introduction

The impact of underground economic activity cannot be overstated. At the macroeconomic level, employment and production numbers can be misrepresented without an accurate account of the underground economy.Is eight percent of the population truly unemployed? Or are portions of the official unemployed working in the unofficial economy?Is GDP really growing at three percent? Or is it growing at a higher rate, but some of the growth is in the unofficial economy? Without an accurate knowledge of the underground economy these questions cannot be answered. For policymakers, in particular, knowing the size of the underground economy would be extremely useful. Decisions concerning state budgets are directly affected by the desired enforcement level against underground economic activity that policymakers choose. Also, on a microeconomic level information about the underground economy can be important for measuring whether taxpayers feel overburdened or not.Growth in underground economic activity might indicate this. If workers are working less, it could be due to marginal tax rates being too high. Again, this would be very useful information for policymakers.

What exactly constitutes underground economic activity? The list is long; it can include the obvious activities, such as illegal drug trade and prostitution and the not so obvious, such as weekend do-it-yourself work. Mirus and Smith (1997) deconstruct underground economic activity into the following categories: illegal activities involving monetary transactions (e.g. prostitution, illegal drug production and trade, sale of stolen property, etc.); illegal activities without monetary transactions (theft for your own use would be one example of this); legal activities involving monetary transactions and tax evasion (e.g. unreported income from self-employment); legal activities involving monetary transactions and tax avoidance (employee discounts, for example); legal activities with tax evasion and no monetary transactions (bartering); and finally, legal activities with tax avoidance and no monetary transactions (the work done by the weekend do-it-yourselfer).Causes for participation in the underground economy are numerous. High tax rates are one. If taxes are high, then rewards for avoidance and evasion are greater. Regulation of markets is another.

Illegal goods and services have no legal markets, so any agent that specializes in these goods and services will have no choice but to trade in the underground economy. Regulation can also come in the form of how you participate in the economy as opposed to whether you can participate or not. Examples of this are minimum wage laws, price ceilings, and maximum work hours, to name a few. Other possible causes mentioned in the literature are low tax morale, lack of trust in government and unemployment.Theories to explain and methods to measure underground economic activity abound. Economics, psychology and political science are just some of the disciplines that have attempted to tackle this problem.Unfortunately to date, none offer completely satisfactory results. In their work on underground economies, Schneider and Enste (2000) conclude that only an interdisciplinary approach--both in theory and empirics--will yield a better understanding of why underground economies exist and a more precise measurement of underground economic activity.

By far, the greatest efforts to measure underground economies have been done at the national level. Developing nations have been the most common target. These tend to have the largest underground economies since their markets and institutions are often not well established. Some interest has been given to developed nations, but mostly as a point of comparison with the developing ones. However, thus far, very little investigation has been done at the regional level.In this paper we examine and measure underground economic activity at the state level in the US.We use the Electricity Consumption Method (or Physical Input Method) as given by Lackó (2000). From 1998 through 2010, we find that Alabama, Georgia and Colorado have the highest underground economic activity and in Tennessee, Vermont and Nebraska the least amount of underground economic activity occurs.

The rest of the paper is organized as follows: Section II gives a survey of the variety of measurement techniques for capturing underground economic activity; Section III describes the data and its sources; Section IV discusses the methodology used here; the results are discussed in Section V; and Section VI provides concluding remarks.

II.Measurement of the Underground Economy

There are two styles of approach for estimating underground economies: directly and indirectly. The most common direct methods are surveys and tax returns. Surveys can be extremely insightful, but only if truthful responses are elicited from participants. This can prove to be difficult when the information requested concerns illegal activities. These methods are important, however. If surveys are constructed properly and answered sincerely, they can reveal specific characteristics of agents that participate in underground activities.Information obtained in tax audits can also be used to estimate the size of an underground economy. In the US the IRS periodically publishes information on its annual audits of tax payers.[1] Compliance levels are examined by comparing selected declared incomes and audit results for these individuals. Another method is to use the gap between voluntarily paid income taxes and that which is owed to estimate a tax gap. Both of these can be used to estimate underground economic activity.

Both of these methods have a number of issues. Schneider and Enste (2000) point out that these approaches only supply a point estimate of underground economic activity. Therefore, long run information about the behavior of underground economies is lost. Additionally, they argue that both methods, at best, can only uncover portions of the underground economy. A survey cannot be set up to capture all types of underground economic activity. Similarly, tax audits only uncover activity that is successfully detected. In particular, neither method is likely to capture the illegal activities portion of the underground economy. Participants in surveys have an incentive to not report illegal activities for fear of prosecution. Audits by the IRS can only hope to pinpoint undeclared income, but income from illegal activities will be missed.[2]

Numerous indirect methods attempt to remedy these issues. They vary from examination of discrepancies between official statistics to inspection of specific statistical ratios to econometric estimations. The advantages of these approaches are that they allow for a better understanding of underground economies over time and capture all portions of underground economy. With these estimates more assumptions have to be made, but the information gained tends to be more descriptive than that obtained from direct methodologies. Two methods use discrepancies in official statistics to measure underground economies. In a study of the US, Park (1979) compares the income portion of GNP to the expenditure portion.

[1]See the Internal Revenue Service website at www.irs.gov.
[2] A prostitute or drug dealer, for example, would never be discovered in an IRS audit since they would be foolish to declare their income in the first place.

Examining the period from 1947 to 1977, Park uses the difference in expenditures and income to describe the US underground economy. O'Neill (1983) uses another discrepancy measure. He assumes that total labor force participation is constant. Then, the changes in labor force participation are used to estimate the size of the underground economy. Hence, if less people are participating in the labor force, an increase in participation in the underground economy is expected. Theoretically, the income-expenditure method should be very accurate, but unfortunately there is no measure of expenditures that does not include some error term. For that matter, expenditure measures usually suffer from omissions as well. Not knowing the exact magnitude of these errors plus the certainty of omissions in the expenditure measure guarantee inaccuracies in any estimate for the underground economy when using this method. A problem with the labor participation method is that it does not distinguish between those that work in both economies. Also, while the assumption that the labor force is constant may be problematic for some, the assumption that declines in official labor force participation imply increases in unofficial labor force participation is much more so. After all, not everyone that leaves the official labor force will go directly to the unofficial labor force. Some may be choosing leisure over labor and not the implied unofficial labor over official labor.

Feige (1979) developed what was probably the first truly important method for measuring underground economic activity -- the transactions approach. In this approach the number of transactions for an economy is used to estimate the size of GNP. A comparison is then made to the official GNP. The difference between these two numbers gives a representation of the underground economy. The Fischer equation for the quantity of money is the centerpiece of this method

$$M * V = P * T \qquad (1)$$

where*P* represents the price level, *T*, the number of transactions; *M* equals the money supply and *V* is the velocity of money. Of course, *T* cannot be measured, so the following relationship is used:

$$P * T = GNP \qquad (2)$$

Empirically, however, this method has some weaknesses. In this approach several necessary assumptions are made. One of the assumptions is that there is a constant relationship between the number of transactions in an economy and GNP. Another is that the velocity of money in the illegal economy is considered to be equal to the velocity in the legal economy. A final assumption is that a base year is needed in which no underground economic activity is said to exist. Commonly, the base year is taken from the late 1920s or the early 1930s. Also, what if the difference in *M*V* and the official GNP is due to imprecise measurements of the number of transactions in the economy? For example, how can financial transactions be excluded? If this is the case, then, the same problem exists as with the discrepancy measures above. Errors in measurement are being counted as underground economic activity. In fact, it is reasonable to assume that there must be some error in measuring transactions in an economy. As stated earlier, theoretically this approach is attractive, but empirically some issues exist. Another common criticism is the velocity of money assumption. There is no clear reason why the velocity of money in the underground economy should be the same as that of the official economy.

Probably, the most popular current method is the currency demand approach. This method was started by Cagan (1958) and later evolved into its present day version at the hands of Tanzi (1980). This method takes advantage of the assumption that underground economic activity should increase as tax pressure does. This is the first time this channel is explored. Also, for the first time, underground economic activity can be estimated econometrically. The regression equation is as follows:

$$ln\left(\frac{C}{M}\right)_t = \beta_0 + \beta_1 ln\left(1 + \frac{T}{Y}\right)_t + \beta_2 ln\left(\frac{W}{Y}\right)_t + \beta_3 lnR_t + \beta_1 ln\left(\frac{Y}{N}\right)_t + \varepsilon_t \qquad (3)$$

C is currency held; *M* represents the money supply; *T* is the average tax rate; *Y* is GNP; *W* represents wages and salaries; *R* is interest paid on savings; and *Y/N* is per capita GNP with the expected signs being $\beta 1, \beta 2, \beta 3 > 0$ and $\beta 4 < 0$. The subscript *t* represents time.

From this equation, currency held can be forecast based on the actual tax rate. Then, it is predicted for the case of no taxes (i.e. T = 0). Comparing the two results, the amount of cash used in the illegal economy can be estimated. This is multiplied by the velocity of money and compared to actual GNP to get an estimate of the underground economy as a percentage of GNP.

Again, it has the same drawback as the previous approach in that the velocity of money is considered to be the same in both underground and official economies. Also, tax pressure is assumed to be the only cause of underground economic activity. For example, regulation, morality and trade of illegal goods are ignored. Another criticism is that cash is assumed to be the only means of exchange in the underground economy. While illegal cash is almost perfectly liquid and would seem to be the preferred instrument of exchange in the underground economy, it is not clear that this always would be the case.[3]

A more recently developed measure is the latent variable method, also known as the MIMIC model ("Multiple indicators, multiple causes"). In the early 1980s several economist applied a new method to the measurement of underground economic activity.[4] Observable indicators are used to describe variables that might accurately measure the size of the underground economy. For example, if the underground economy grows, we would expect there to be more monetary transactions, decreases in the official labor force participation and inputs moving from the official economy to the underground one. This might be reflected by changes in monetary indicators, the labor market and the production market. In short, the causes and indicators of underground economic activity are observable, but the actual underground economy is not (hence, latent). However, once the relationship between the causes and the indicators has been estimated, the size of the unofficial economy can be inferred.

After addressing some unit root issues, Giles (1999) identifies several variables that are both causal and measurable. They are: average tax rates, marginal tax rates, inflation, real income, and regulation. He also identifies the following measurable indicator variables: The rate of male participation in the labor force and the currency to money supply ratio. Like the currency demand approach, this method looks at the demand for currency, but unlike that approach, this method allows for differing velocity of money in the official and unofficial economies. The currency demand equation is used to compute a long-run ratio of the underground activity to the measured activity in the economy. The MIMIC results are used to produce an index of underground economic activity. This index is then multiplied by the long-run average given by the currency demand estimate.

The major criticism of this approach is that the procedure for determining the indicator and causal variables is very ad hoc. How do we know if those are the only variables needed? There is no theoretical model to back these choices up. This model, however, is attractive in that it allows for varying velocities of money. While still not as popular as Tanzi's currency demand approach, it is making inroads, especially since the nonstationarity and cointegration issues have been addressed.Notwithstanding, none of the three previously mentioned models -- transactions approach, currency demand approach and the MIMIC -- could be applied to regional analysis of underground economic activity. All three methods depend on information about the money supply. Not having this data at the state level renders these three methods useless for the scope of the analysis in this paper.

There is, however, a method that does not depend on the money supply: The physical input method. It attacks the measurement problem from a different angle. Empirically it has been shown throughout the world that consumption of electricity and GDP have an elasticity of nearly one.[5] Two variations of this approach exist. One is attributed to Kaufmann and Kaliberda (1996) and the other to Lackó (2000).The Kaufmann-Kaliberda method is a hybrid of both direct methods and indirect ones. It uses micro-surveys and macro data on electricity consumption to estimate the expected GDP of an economy. This is then compared to the officially measured one and the difference is credited to the unofficial economy.

Again, using electricity consumption, the Lackó method econometrically estimates underground economic activity. First, a proxy for underground economic activity is estimated. The results are used to rank the countries by electricity use in their underground economies. To convert this information into an actual measure of underground economic activity the amount that electricity contributes to GDP is needed. This method does not provide this information. To do this, an estimate using another method is taken for one of the countries in the study. A ratio is created using this estimate. This ratio is then applied to the other countries and their underground economic activity is then calculated.As with the other methods, this approach does not lack for critics. For one, while the elasticity of GDP and electricity use may be around one, this does not mean that this relationship exists in the underground economy.

[3] Bartering is one example of this.
[4] See Frey and Weck-Hannemann (1984).
[5] Dobozi and Pohl (1995) and Dobozi (1995).

Furthermore, whether this relationship exists over time is also questionable; especially given that over time we seem to be more efficient at using electricity. Another shortcoming of this method is that it only focuses on households. Underground economic activity need not be limited to households. Firms certainly participate in the underground economy. Finally, the underground economy of the base country in this method depends on both accurate measurements from a different method and that this base country's underground economy is truly representative of other nations' underground economies. In fact, even if the physical input method were infallible, it would still depend on the base estimate using another distinct measurement being error-free as well.Criticisms aside, this method lends itself to analysis of underground economic activity at a regional level. For this reason, this method with some adjustments and additions will be used to measure underground economic activity at the state level in US. A more detailed description of the method to be used in this paper follows.

III.Data

All energy data, which includes electricity consumption, price of electricity and consumption of non-electrical energy, comes from the US Energy Information Administration. Both electricity consumption (coded ESTXB) and non-electrical energy consumption (TETXB minus ESTXB) are measured in British thermal units (Btu's). The price of electricity (coded ESTXD) was converted to real terms using the Consumer Price Index (CPI) and represents the price household pay for one million Btu's of electricity. From the Bureau of Economic Analysis (BEA) we obtained the following data: real Gross State Product (GSP), tax receipts, government spending. Also, from the BEA we received the nominal GSP; with nominal GSP we were able to create a GSP deflator to use as our inflation variable. The heating-degree and cooling-degree days are housed at the US Department of Commerce in its National Climatic Data Center. We received the crime data from the US Sentencing Commission.Our data is annual and ranges from 1998 through 2010. This range was determined by the availability of the data with crime data being the limiting factor. It is a longitudinal data set and therefore, both state- and time-fixed effects are considered. There are 637 observations. Due to the limitations of data for heating- and cooling-degree days, we included neither Alaska nor Hawaii in our sample.

IV. Methodology

Underground economic activity is assumed to be prevalent in all areas of the economy. Electricity consumption is said to depend on real production, the real price of electricity, the weather, the intensity of electrical energy usage in the entire economy and finally, the underground economy. Real production, the weather and underground economic activity are expected to have a positive effect on electricity consumption, while the price of electricity is expected to have an indirect relationship with electricity consumption. As production increases, electricity usage should increase as well. With more underground economic activity we should also witness a surge in electricity consumption. Concerning weather, it is assumed that electricity is used to heat and cool homes and therefore both hotter and cooler weather will cause higher consumption of electricity. The expected effect of the consumption of non-electrical energy is ambiguous; it could be the case that one crowds out the other or it could be the case that both move together driven by other factors. These relationships are expressed in equation (4):

$$E_{i,t} = \beta_0 + \beta_1 GSP_{i,t} + \beta_2 W_{i,t} + \beta_3 Other_{i,t} + \beta_4 Price_{i,t} + \beta_5 Under_{i,t} + \varepsilon_{i,t} \qquad (4)$$

The variables *E*and *Other* represent electricity and non-electrical energy consumption, respectively; both are measured in Btu's. The variable *GSP* represents per capita real Gross State Product and *Price* is the household price in real terms for one million Btu's of electricity. The variable *Under* represents underground economic activity and is a latent variable. The subscripts *i* and*t* stand for US state and time, respectively. All variables are in log form with the exception of the underground economy variable. The coefficients β_1,β_2 and β_5 are expected to be greater than zero while β_4 should be less than zero and the sign of β_3 is ambiguous.Underground economic activity is considered to be a function of overall tax pressure, the annual inflation rate, crime and the size of government. High inflation rates would cause more underground economic activity due to worse conditions in the official economy, making the underground economy more attractive. For obvious reasons higher crime rates would be a signal of higher participation in the underground economy. Government spending and taxes are also included as a controls as suggested by the literature; the actual effect for both is ambiguous. For taxes at first glance, this may seem controversial, but higher taxes, for example, may drive people into the underground economy, but it could also be an indicator that the government is capturing more of the underground economic activity. Equation (5) describes the underground economy:

$$Under_{i,t} = \alpha_1 Crime_{i,t} + \alpha_2 T_{i,t} + \alpha_3 I_{i,t} + \alpha_4 G_{i,t} + \mu_{i,t} \quad (5)$$

The variable *Crime*, as its name indicates, is the crime variable and is the number of felony sentences by state. The variable *T* is a ratio of real tax receipts to real GSP and *G* is the ratio of real government spending to real GSP. The inflation variable *I* is the GSP deflator. As discussed earlier, α_1 and α_3 are expected to be greater than zero with the remaining coefficients being ambiguous. Again, all the variable except the underground economic activity variable are in log form and the subscripts are as described earlier.

Given that *Under* is not known, equation (5) cannot be estimated directly. Therefore, the estimation is done combining equation (5) into equation (4) and *Under* is estimated as a latent variable. Once the regression is run, a ranking is established based on the ratio of the underground economic activity to electricity demand ($Under_{i,t}/E_{i,t}$ = underground economy index). This is described by equation (6) below:

$$Underground\_Index_{i,t} = \frac{\alpha_1 Crime_{i,t} + \alpha_2 T_{i,t} + \alpha_3 I_{i,t} + \alpha_4 G_{i,t}}{E_{i,t}} \quad (6)$$

This alone, however, does not tell the complete story. In order to estimate the size of the underground economy, a previous estimate using a different procedure for one state *i* at a similar time *t* must be used. The ratio of the index from the model to the outside-the-model estimate is then used to adjust all $Underground\_Index_{i,t}$ and this gives the size of the underground economy for each. For example, if the outside estimate for state Awas 20%, then the estimate for state B would be:

$$\left(\frac{Modelestimateforstate B}{Modelestimateforstate A}\right) * 20$$

This is done for all *i* and all *t*. Again, the ability to accomplish this depends on the acceptance of the assumption mentioned earlier as given by Dobozi and Pohl (1995) and Dobozi (1995) in which the elasticity of electrical consumption and real GDP (here, real GSP) is close to one.

V.Results

After combining equations (5) & (6), the following is estimated:

$$E_{i,t} = \delta_0 + \delta_1 GSP_{i,t} + \delta_2 W_{i,t} + \delta_3 Other_{i,t} + \delta_4 Price_{i,t} + \delta_5 Crime_{i,t} + \delta_6 T_{i,t} + \delta_7 I_{i,t} + \delta_8 G_{i,t} + \omega_{i,t} \quad (7)$$

whereδ_1, δ_2, δ_5, and δ_7 are expected to be greater than zero; δ_4 is expected to be less than zero with δ_3, δ_6, and δ_8 being either. The results are given in Table 1 located in Appendix A.From Table 1 it can be seen that the results are as expected. Most of the variables are statistically significant, except for the income variable, the crime variable, and both the tax and government spending variables.

To find the magnitude of underground economic activity a point of comparison is needed. Here, we use various outside estimates of underground economic activity in the US: 8.8%in1997 (Schneider and Pöll, 1999); 10.5% in 1990 (Lackó, 2000); and 13.9% average from 1990 to 1993 (Johnson et al, 1998). We assume that US underground economic activity in 1998 equals these outside estimates. While this is not likely to be true, what we are after is a ranking of states by size of underground economies. We would expect the estimates using the Schneider-Pöll result to be the most accurate, but we include the others since they were estimated by a variety of different methods. No matter the outside estimate, the rankings will not be affected.

Equation (6) estimates a production-electricity ratio which is then compared to the outside hidden economy ratio given for the US. All state underground economies are then calculated as explained earlier. The results can be seen in Appendices B through D. Alabama, Georgia and Colorado are the states with the highest estimated underground economic activity and Vermont, Nebraska and Tennessee are the states with the lowest estimates.

VI. Conclusion

This paper uses the physical input method to measure underground economic activity in the US at the state level. Specifically, observable electricity consumption is used to indirectly estimate underground economic activity. This is an innovative approach that is more accurate than other popular methods. Using this method we develop a ranking of US states in terms of underground economic activity.

We find that Alabama, Georgia and Colorado have the highest estimated underground economic activity over the examined time period, while Vermont, Nebraska and Tennessee have the lowest estimates. We calibrate the estimates for several different base rates of underground economic activity in US and find a range of plausible percentages, but the rankings remain unchanged.While this paper demonstrates an innovative method for estimating underground economic activity, it is not without limitations. First, we emphasize that the core result of the study is the state ranking. As demonstrated in the paper, the actual levels of estimated underground economic activity can fluctuate substantially based on the rate used for calibration. Furthermore, we offer no explanation for the ranking of underground economic activity across states as this is outside of the scope of the study. These determinants however are critical to truly understanding the causes of underground economic activity and for formulating potential policies. These avenues should be explored in future work.

References

Cagan, P. "The Demand for Currency Relative to the Total Money Supply," *Journal of PoliticalEconomy*, 66(3), August 1958, 302-328.

Dobozi, I., "Electricity Consumption and Output Decline - An Update," *Transition*, 6(9-10), 1995, 19-20.

Dobozi, I. and G. Pohl, "Real Output Declines in Transition Economies - Forget GDP, Try Power Consumption Data!" *Transition*, 6(1-2), 1995, 17-18.

Feige, E.L., "How Big is the Irregular Economy?" *Challenge*, 22(1), November/December 1979, 5-13.

Frey, B. and H. Weck-Hannemann, "The Hidden Economy as an 'Unobserved' Variable," *EuropeanEconomic Review*, 26(1-2), 1984, 33-53.

Giles, D.E.A., "Measuring the Hidden Economy: Implications for Econometric Modelling," *Economic Journal*, 109(456), June 1999, 370-380.

Kaufmann, D. and A. Kaliberda, "Integrating the Unofficial Economy into the Dynamics of Post SocialistEconomies: A Framework of Analyses and Evidence," World Bank Policy Research Working Paper No. 1691, December 1996.

Johnson, S., D.Kaufmann and P. Zoido-Lobatón. "Regulatory Discretionand the Unofficial Economy,"*American Economic Review*, 88:2, 1998, pp. 387–92.

Lackó, M., "Hidden Economy - An Unknown Quantity?" *Economics of Transition*, 8(1), 2000, 117-149.

Mirus, Rolf and Roger S. Smith. 1997. "Canada's Underground Economy: Measurement and Implications," in*The Underground Economy: Global Evidence of its Size and Impact*.OwenLippert and Michael Walker, eds. Vancouver:Fraser Institute.

O'Neill, David M. 1983. "Growth of the Underground Economy 1950–81: Some Evidencefrom the Current Population Survey," Study forJoint Economic Committee, 98:122, U.S. GovernmentPrinting Office, Washington, DC.

Park, Tea. 1979. "Reconciliation Between PersonalIncome and Taxable Income," Bureau of Economic Analysis, Washington DC.

Schneider, F., and Enste, D.H.. "Shadow Economies: Size, Causes, and Consequences." *Journal ofEconomic Literature*, 38:1 (March 2000): 77-114.

Schneider, Friedrich and GüntherPöll."Schattenwirtschaft," inHandbuch der Wirtschaftsethik.Wilhelm Korff, ed. Güthersloh:Gütersloher Pub, 1999.

Tanzi, V. "The Underground Economy in the United States: Annual Estimates, 1930-1980." IMF StaffPapers 30:2 (1983): 283-305.

Appendix A

Electricity Demand

Variable	Estimate	Standard Error
GSP	0.06	0.04
W	0.08**	0.03
Other	0.49***	0.03
Price	-0.13***	0.02
Crime	0.01	0.01
T	-0.02	0.03
I	0.22***	0.05
G	-0.04	0.03
Constant	3.03***	0.61
Observations	637	
R^2	0.96	

The dependent variable is *E* which represents the log of electrical consumption. The independent variables are: *W* (heating- and cooling-degree days), *Other* (non-electrical energy consumption), *Price* (price of electricity), *Crime* (felony sentences), *T* (tax receipts/GSP), *I* (GSP deflator), *G* (government spending-to-GSP ratio). A detailed description of the variables are given in the paper. State- and year-fixed effects are included in the estimation but not reported. ***p<0.01, **p<0.05, *p<0.10

Appendix B

USA			9.24	
Alabama	13.53		North Carolina	1.87
Arkansas	7.77		North Dakota	8.86
Arizona	5.95		Nebraska	0.03
California	7.75		New Hampshire	4.13
Colorado	9.40		New Jersey	1.92
Connecticut	5.47		New Mexico	6.57
Delaware	5.25		Nevada	3.05
Florida	2.22		New York	5.82
Georgia	10.39		Ohio	8.62
Iowa	8.58		Oklahoma	8.66
Idaho	4.94		Oregon	5.87
Illinois	4.22		Pennsylvania	6.43
Indiana	8.10		Rhode Island	8.37
Kansas	7.32		South Carolina	1.07
Kentucky	4.90		South Dakota	8.01
Louisiana	7.73		Tennessee	0.57
Massachusetts	5.20		Texas	8.20
Maryland	6.40		Utah	3.61
Maine	7.18		Virginia	7.92
Michigan	1.29		Vermont	0.03
Minnesota	7.53		Washington	7.50
Missouri	6.14		Wisconsin	6.58
Mississippi	7.17		West Virginia	4.83
Montana	6.15		Wyoming	1.22

This table shows the percentage of economic activity that is underground as estimated by the Physical Input method. Here, the model is calibrated using 8.8% for the US in 1997 as estimated by Schneider and Pöll (1999); we assume that the underground economy in 1998 is the same size as in 1997.

Appendix C

USA			11.02
Alabama	16.14	North Carolina	2.23
Arkansas	9.27	North Dakota	10.57
Arizona	7.10	Nebraska	0.04
California	9.25	New Hampshire	4.93
Colorado	11.22	New Jersey	2.29
Connecticut	6.52	New Mexico	7.84
Delaware	6.26	Nevada	3.63
Florida	2.65	New York	6.94
Georgia	12.40	Ohio	10.28
Iowa	10.23	Oklahoma	10.33
Idaho	5.89	Oregon	7.01
Illinois	5.04	Pennsylvania	7.67
Indiana	9.66	Rhode Island	9.99
Kansas	8.73	South Carolina	1.28
Kentucky	5.84	South Dakota	9.56
Louisiana	9.23	Tennessee	0.68
Massachusetts	6.21	Texas	9.79
Maryland	7.64	Utah	4.31
Maine	8.56	Virginia	9.44
Michigan	1.54	Vermont	0.03
Minnesota	8.99	Washington	8.95
Missouri	7.32	Wisconsin	7.85
Mississippi	8.55	West Virginia	5.76
Montana	7.34	Wyoming	1.46

This table shows the percentage of economic activity that is underground as estimated by the Physical Input method. Here, the model is calibrated using 10.5% for the US in 1990 as estimated by Lackó (2000); we assume that the underground economy in 1998 is the same size as in 1990.

Appendix D

USA			14.59
Alabama	21.37	North Carolina	2.95
Arkansas	12.27	North Dakota	14.00
Arizona	9.40	Nebraska	0.05
California	12.24	New Hampshire	6.52
Colorado	14.86	New Jersey	3.03
Connecticut	8.63	New Mexico	10.38
Delaware	8.29	Nevada	4.81
Florida	3.51	New York	9.19
Georgia	16.41	Ohio	13.61
Iowa	13.55	Oklahoma	13.68
Idaho	7.80	Oregon	9.27
Illinois	6.67	Pennsylvania	10.15
Indiana	12.79	Rhode Island	13.22
Kansas	11.56	South Carolina	1.70
Kentucky	7.73	South Dakota	12.65
Louisiana	12.21	Tennessee	0.90
Massachusetts	8.22	Texas	12.96
Maryland	10.11	Utah	5.70
Maine	11.34	Virginia	12.50
Michigan	2.04	Vermont	0.04
Minnesota	11.90	Washington	11.85
Missouri	9.69	Wisconsin	10.39
Mississippi	11.32	West Virginia	7.63
Montana	9.72	Wyoming	1.93

This table shows the percentage of economic activity that is underground as estimated by the Physical Input method. Here, the model is calibrated using 13.9% for the US between 1990 and 1993 as estimated by Johnson et al (1998); we assume that the underground economy in 1998 is the same size as it was from 1990 to 1993.