Measuring unobserved economy

through electricity demand

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Goals of the paper

- Unobserved economy is a widespread phenomenon that poses serious social, economic, cultural and political challenges across the world. Although it is a subject of considerable interest, many issues about its nature and consequences still remain largely under-explored or unresolved

- We aim at measuring the size and development of the unobserved economy in Italy using a physical input, the electricity consumption. What is the relationship between the electricity consumption and the size of the unobserved Economy?

- We apply the electricity consumption method to a panel of 103 Italian provinces (NUTS-3 level) for the years 2004-2012

Defining and analyzing the unobserved economy

We can find definitions of unobserved economy from various points of view, economical, legitimate, juridical, social and other:

- Unobserved economy comprises production activities that are illegal, underground, informal, or otherwise missed by the statistical system (OECD, 2002)

- All the unregistered economic activities that contribute to the officially calculated (or observed) gross national product (Feige, 1994; Schneider, 2005)

- Any economic activity which increases the total value of national product, but it is not included in national account or shown in gross domestic product (Startienė and Trimonis, 2010)

Unobserved economy measurement in the literature

Measurement of the unobserved economy is inherently difficult because of the very nature of its activity. How should the unobserved economy be estimated?

- The **direct methods** are usually microeconomic and estimate the size of the unobserved economy by voluntary replies on surveys or tax auditing methods

- The **indirect methods** are mostly macroeconomic and use economic and non-economic indicators that contain information about the development of the unobserved economy over time:
  - → discrepancy between national expenditure and income statistics (ISTAT)
  - → discrepancy between official and actual labor force (Franz, 1985)
  - → the transactions approach (ISTAT)
  - → the currency demand approach (CDA) (Cagan, 1958; Tanzi, 1983; Schneider and Enste, 2000; Ardizzi et al., 2014)
  - **→ the physical input (electricity consumption) method (seminal paper, Kaufmann and Kaliberda, 1996)**

- The **MIMIC (multiple indicators, multiple causes) approach** includes statistical models that are used to estimate the unobserved economy as an unobserved (latent) variable (Frey and Weck-Hanneman, 1984; Giles, 1999)

- **DSGE models** analyze unobserved economy and its cyclical behavior in a dynamic stochastic framework (Busato and Chiarini, 2004; Orsi et al. 2014; Argentiero and Bollino, 2015)

Why an electricity demand approach (EDA) instead of CDA?

- There exists a share of unobserved economic transactions not payed by cash

- Some currencies are international reserve currencies and are therefore held independently of specific underlying transactions

- Electricity consumption is able to capture the entirety of the production process (with the corresponding costs) and not only the exchange phase

- Some data related to CDA (cash withdrawals) are not publicly available

Research hypothesis: the role of electricity demand

- The electricity consumption approach uses electric-power consumption as physical indicator of overall economic activity (official + unofficial)

- Electricity consumption to GDP elasticity is usually close to one
  - →this means that the growth of total electricity consumption is an indicator for growth of overall GDP

- As for CDA, electricity consumption is built as a function of
  1. Variables linked to the official economy;
  2. Determinants of unobserved economy

- By setting to zero the coefficients of the determinants of unobserved economy, a measure of **regular** electricity demand is obtained

- By setting to zero the coefficients of the determinants of official economy, a measure of **irregular** electricity demand is obtained

- The corresponding GDPs are derived trough a standard production function where electricity is a production factor

Existing estimates for underground economy in Italy

CONTRIBUTION	METHODOLOGY	SIZE
Enste and Schneider (2000, 2002)	CDA	25.8% (1989-2000)
Zizza (2002)	CDA	16.5% (1984-2000)
ISTAT	Direct methods (labor input)	15.9-17.5% (1992-2008); 12-13% (2009-2013)
Schneider (2015)	MIMIC	27% (1999-2007)
Ardizzi et al. (2013, 2014)	CDA (revised)	16.5% (2005-2008)
Orsi et al. (2014)	DSGE model	23% (1982-2006)
Argentiero and Bollino (2015)	DSGE model	20% (1974-2011)

Existing estimates for criminal economy in Italy

CONTRIBUTION	METHODOLOGY	SIZE
Argentiero et al. (2008) – Money laundering	DSGE model	12% (1981-2001)
Ardizzi et al. (2013) – Money laudenring	CDA (revised)	7% (2005-2008)
Ardizzi et al. (2014)	CDA (revised)	10.9% (2005-2008)
Argentiero and Bollino (2015)	DSGE model	11% (1974-2011)
ISTAT (2014)	Direct (survey)	1% (2011-2013)

Unobserved economy in the world….

How large or small a share of GDP does unobserved economy represent worldwide?

Recent estimates (Schneider et al., 2015) imply that it may account for:

- up to 12% of the total economic activity in Anglo–Saxon countries

- between 20%–30% in southern European nations, with Bulgaria (31.0%) and Greece (23.3%) extremely notable.

- about 40% in developing and transition economies

Data

- Panel data annual observations from 103 Italian provinces (NUTS-3 level) from 2004 to 2012
- Electricity consumption is measured for the Italian productive sectors in Gigawatt (source, Terna)
- Determinants of regular economy:
  - Number of employees (source, ISTAT)
  - Capital Stock (source, ISTAT)
  - Waste recycling, as a proxy of the energy saving attitude (source, ISTAT)
- Determinants of undergound economy:
  - Provincial tax burden (source, Italian Ministry of Economics and Finance)
  - Number of verifications with acceptance (source, Italian Revenue Agency)
- Determinants of criminal economy:
  - Number of reports for thefts and robberies (source, Italian Ministry of Interior)

Econometric strategy

1. The aggregate production function is assumed to be Cobb-Douglas:

$$Yt = At * Kt^{\alpha} * Lt^{\beta} * Et^{\gamma}$$

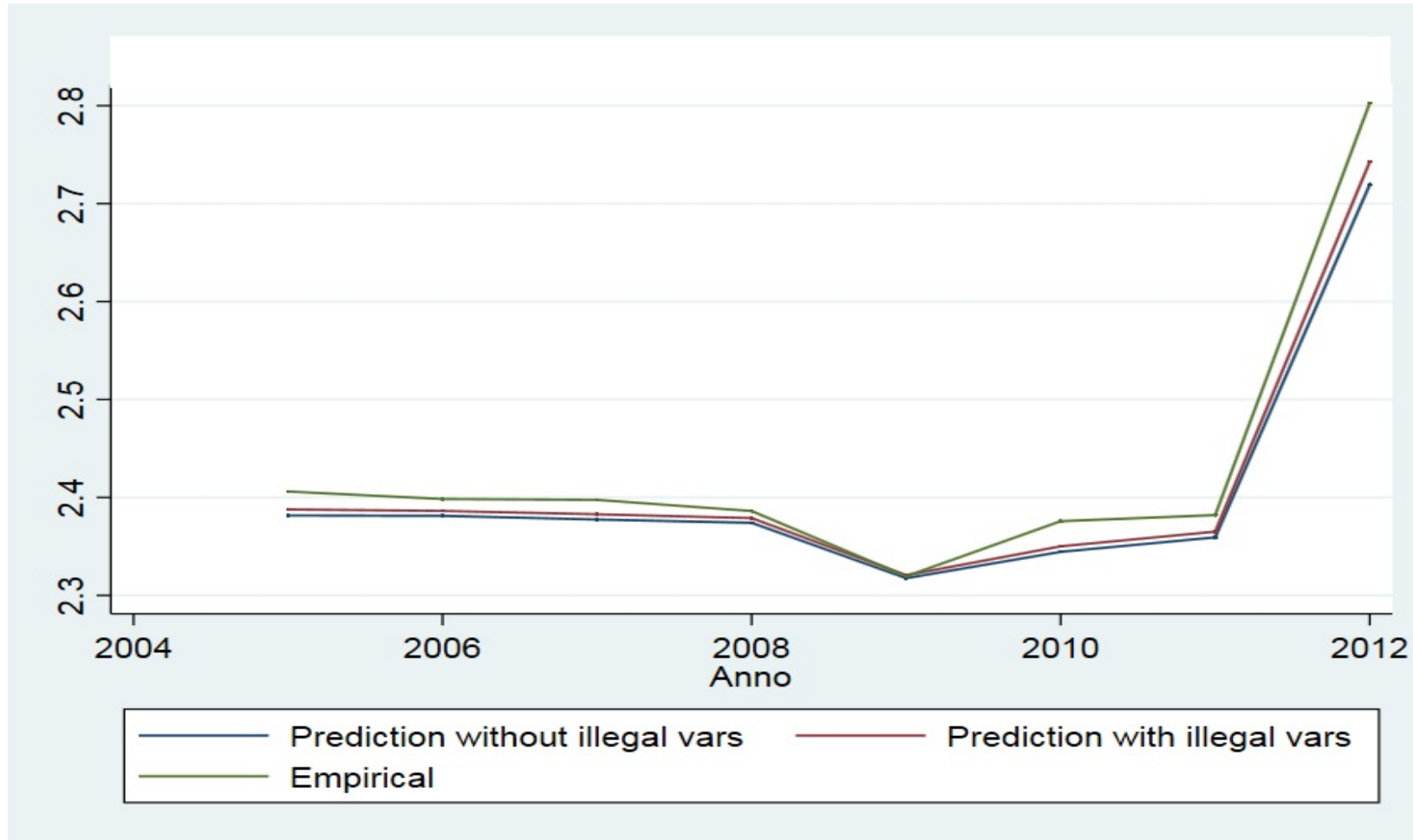2. The optimal energy demand in a perfectly competitive scenario is

$$E_t = \frac{1}{\gamma} * p_{et} * (At * Kt^{\alpha} * Lt^{\beta} * Et^{\gamma})^{[-1/\gamma - 1]}$$

3. Estimated equation

$$\ln(E_{it}) = C + a\,ln(K_{it}) + b\,ln(L_{it}) + c\,ln(A_{it}) + d\,ln(p_{eit}) + e\,ln(X_{it}) + dummy_{crisis} + v_i + \varepsilon_{it}$$

4. Computing GDPs using the Cobb-Douglas function with the rates of irregular labor and capital of ISTAT

Electricity consumption vs regular electricity consumption (predicted)

Preliminary results

DEPENDENT VARIABLE: log (electricity consumptoions)			
log (capital stock)	(0.67)***	(0.71)***	(0.82)***	(0.85)***
log (employers)	(0.14)***	(0.12)***	(0.08)***	(0.10)***
log (electricity_price)	(-0.55)***	(-0.67)***	(-0.50)***	(-0.48)***
log (diff_waste)	(-0.10)***		(-0.05)***	
log (schooling)		(0.29)***		(0.15)***
dummy_crisis	(-0.34)***	(-0.38)***	(-0.21)***	(-0.22)***
log (tax_burden)			(0.06)***	(0.10)***
log (verifications)			(-0.02)***	(-0.01)***
log (thefts_robberies)			(0.09)*	(0.08)*
constant	(1.89)***	(1.99)***	(1.54)***	(1.50)***
R^2overall	0.10	0.08	0.03	0.02
R^2between	0.10	0.09	0.09	0.09
R^2within	0.89	0.81	0.93	0.78
observations	927	927	927	927

Concluding remarks

- By introducing the determinants of the unobserved economy in a standard energy demand function, the prediction gets closer to the empirical value

- According to the EDA the share of unobserved economy is around 30%, consistently with Ardizzi et al. (2014) and Argentiero and Bollino (2015), but higher than ISTAT estimates

- Future agenda:
  - Robustness analysis using other econometric estimators
  - Split unobserved economy into underground and criminal components

Thank you for your attention
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