Australian National University

Does Energy Use Cause Growth or Vice Versa?

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Crawford School of Public Policy

MAER-Net Colloqium, Perth 18-20th September 2012

Energy-Growth Causality Literature

- Kraft & Kraft (1978) *J. Energy & Development*

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- Kraft & Kraft (1978) *J. Energy & Development*
- Large and rapidly growing literature

Energy-Causality Article Database

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Energy-Growth Causality Literature

- Kraft & Kraft (1978) *J. Energy & Development*
- Large and rapidly growing literature
- Little consensus or clearcut results – in our sample:
  - 36% of $E \rightarrow Y$ tests reject the null
  - 39% of $Y \rightarrow E$ tests reject the null

Granger Causality Testing

Vector autoregression (VAR) model:

$$Y_t = \beta_{1,0} + \sum_{i=1}^{p} \beta_{1,1,i} Y_{t-i} + \sum_{i=1}^{p} \beta_{1,2,i} E_{t-i} + \varepsilon_{1t}$$

$$E_t = \beta_{2,0} + \sum_{i=1}^{p} \beta_{2,1,i} Y_{t-i} + \sum_{i=1}^{p} \beta_{2,2,i} E_{t-i} + \varepsilon_{2t}$$

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Choice of Studies

Methodologies:

- Granger, Sims, Hsiao, & Toda-Yamamoto causality tests
- Engle-Granger & Johansen cointegration tests
- Exclude contemporaneous RHS terms
- Exclude levels casuality tests apart from T-Y
- Exclude zero or multiple cointegration vectors

Choice of Studies

Data:

- Annual time series for countries
- No monthly or quarterly
- No panels
- No regions
- No Taiwan

Choice of Studies

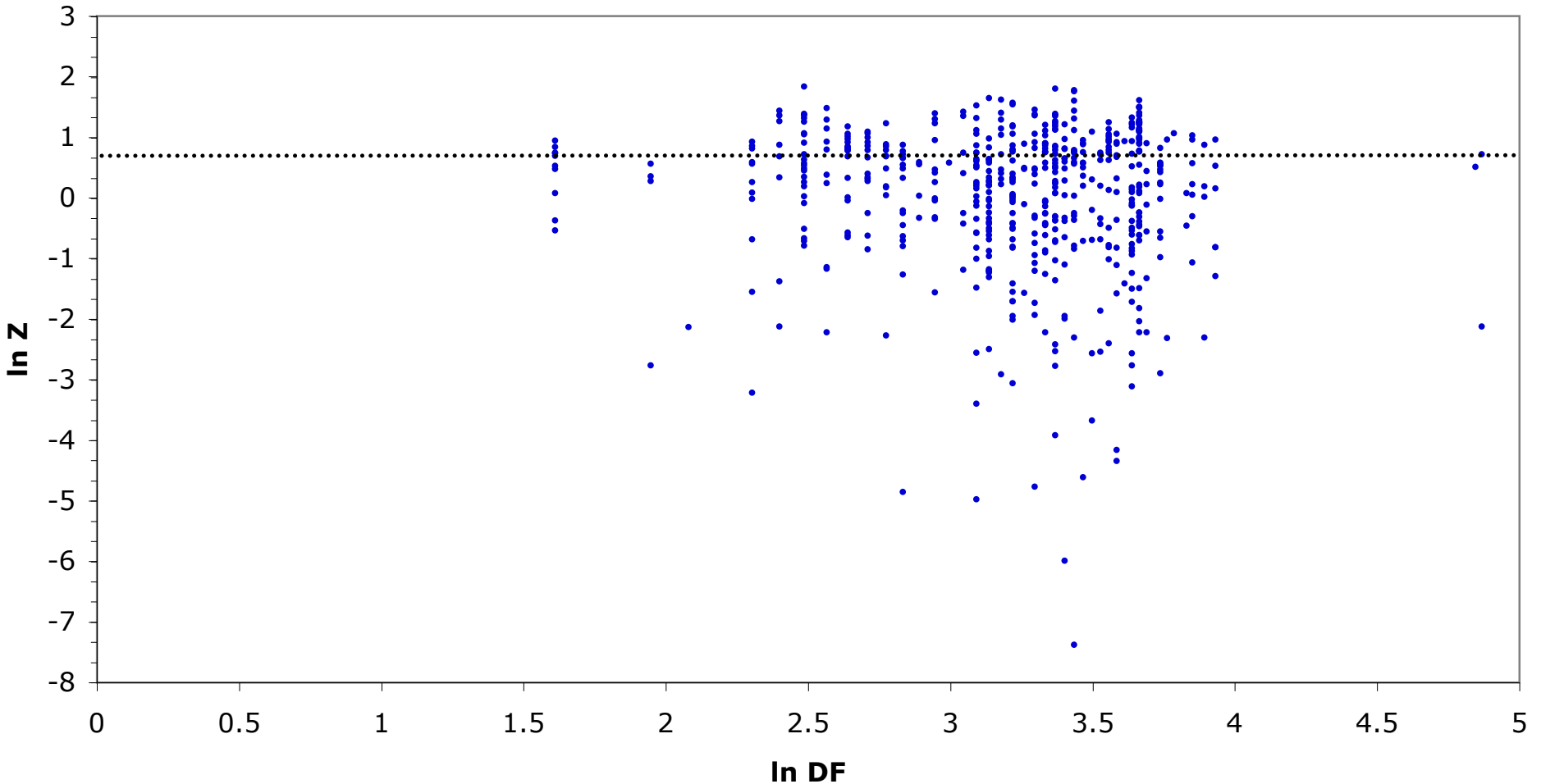
Other reasons for non-inclusion:

- Incorrect or unclear methods or statistics
- Insufficient information (particularly to compute DF)

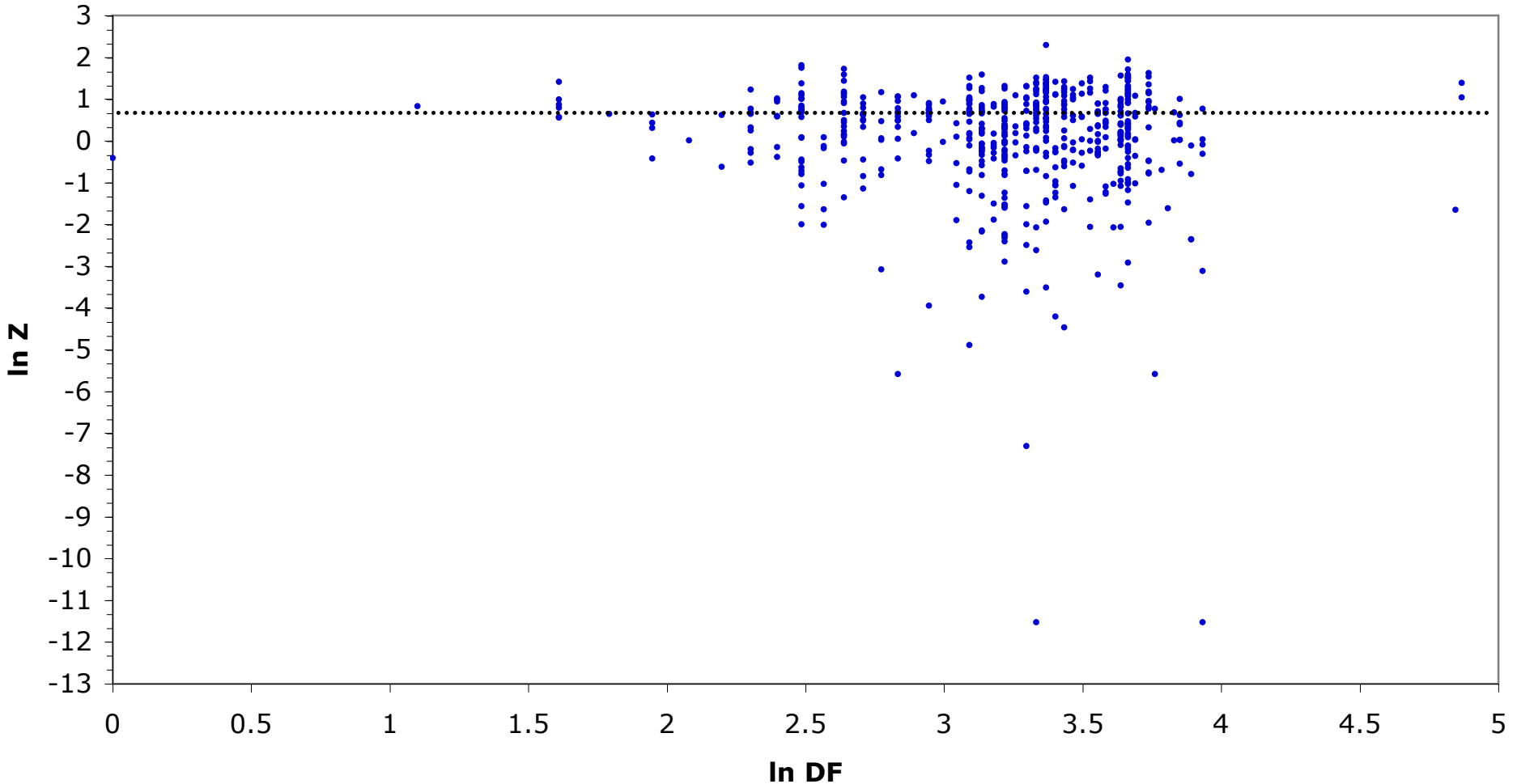
Exploratory Data Analysis

- 72 studies, 574 pairs of tests
- All p-values converted to normal two-tailed test statistics
- Mean Z-Score:
  - $E \rightarrow Y$: 1.615
  - $Y \rightarrow E$: 1.703

Energy Causes Output



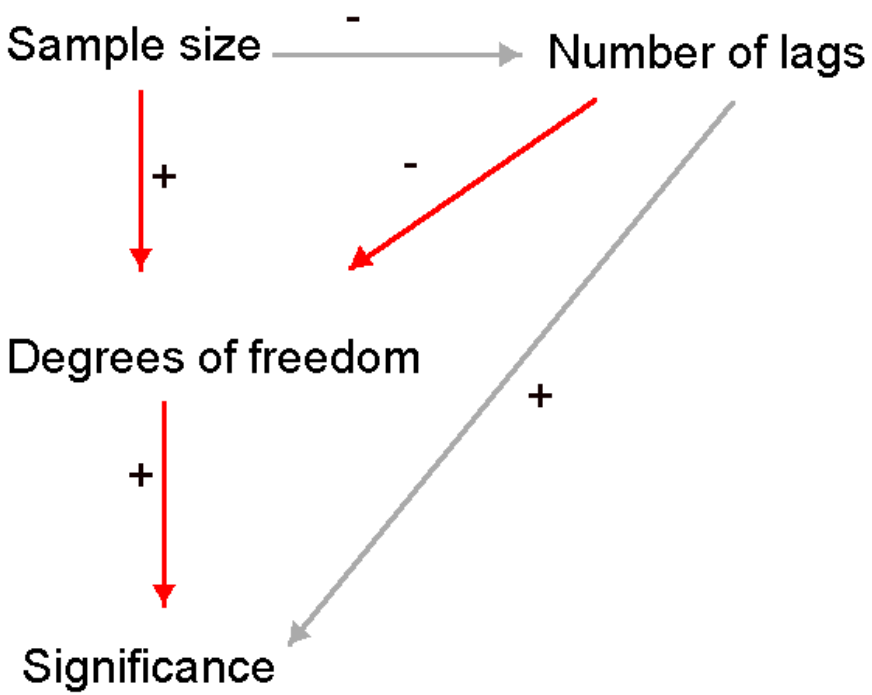
Output Causes Energy



Correlations

	LZEG	LZGE	LDFEG	LDFGE	SAMPLE
LZEG					
LZGE	0.101				
LDFEG	-0.075	-0.042			
LDFGE	-0.044	-0.066	0.887		
SAMPLE	-0.020	-0.024	0.735	0.703	
COEEG	0.113	0.033	-0.624	-0.514	-0.094
COEGE	0.065	0.074	-0.488	-0.630	-0.067
CONTROLS	0.094	0.027	-0.074	-0.084	0.086
LAGSE_EG	0.090	0.017	-0.513	-0.451	-0.062
LAGSE_GE	0.020	0.035	-0.421	-0.571	-0.048
CI	0.178	0.140	0.163	0.149	0.011

Over-fitting and Over-rejection



Control by including COEEG or COEGE in regression

Classic MST Model

$$Z = \alpha_0 DF^{0.5} + v$$

$$v \sim N(0,1)$$

Logarithmic version:

$$\ln|Z| = \ln\alpha_0 + \alpha_1 \ln DF + \varepsilon$$

Residuals are skewed + heteroskedastic when $\alpha_1 > 0$

Alternative MST Models

- Levels model for directional statistics:

$$Z = \alpha + \beta DF^{0.5} + \varepsilon$$

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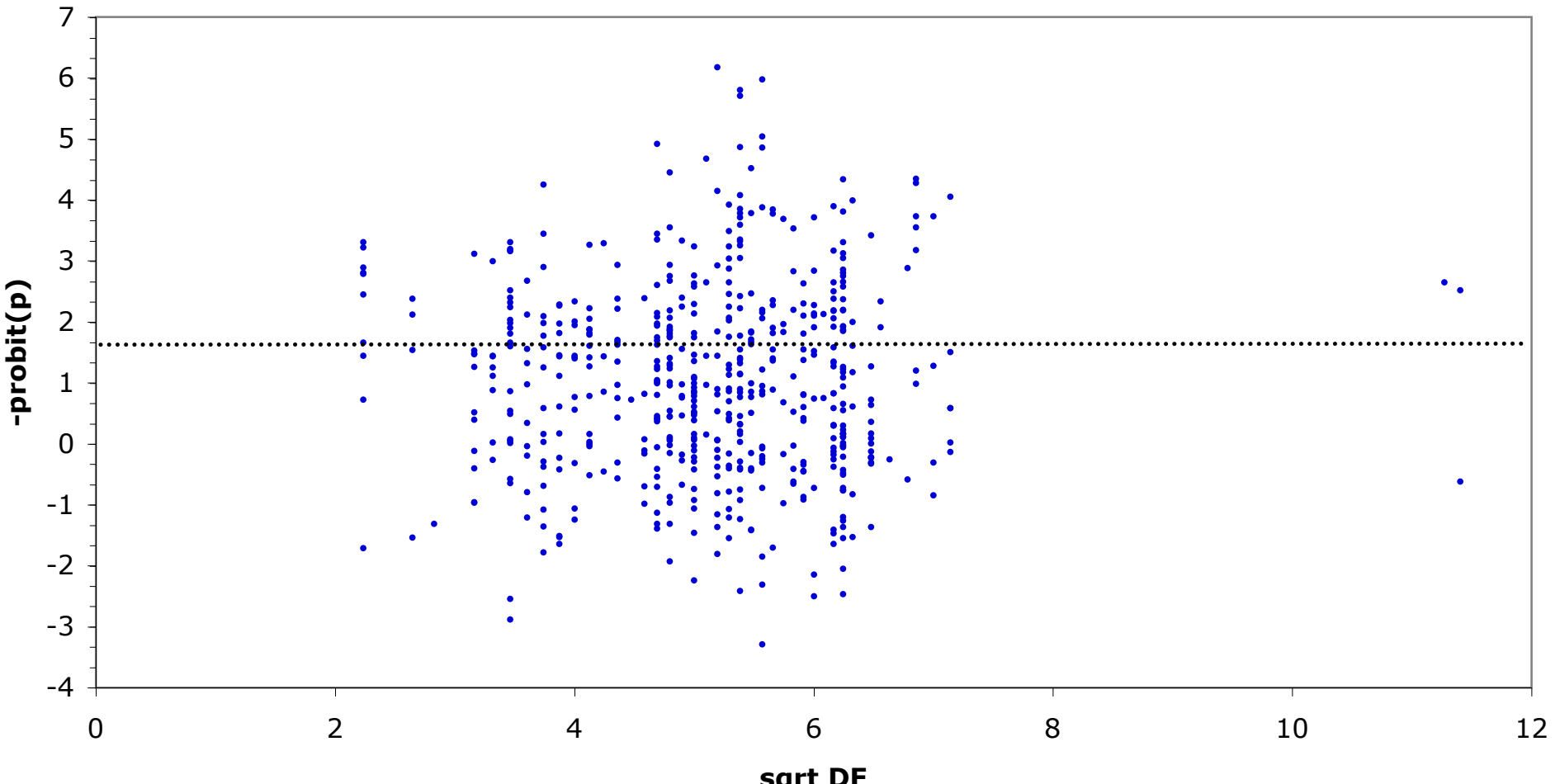
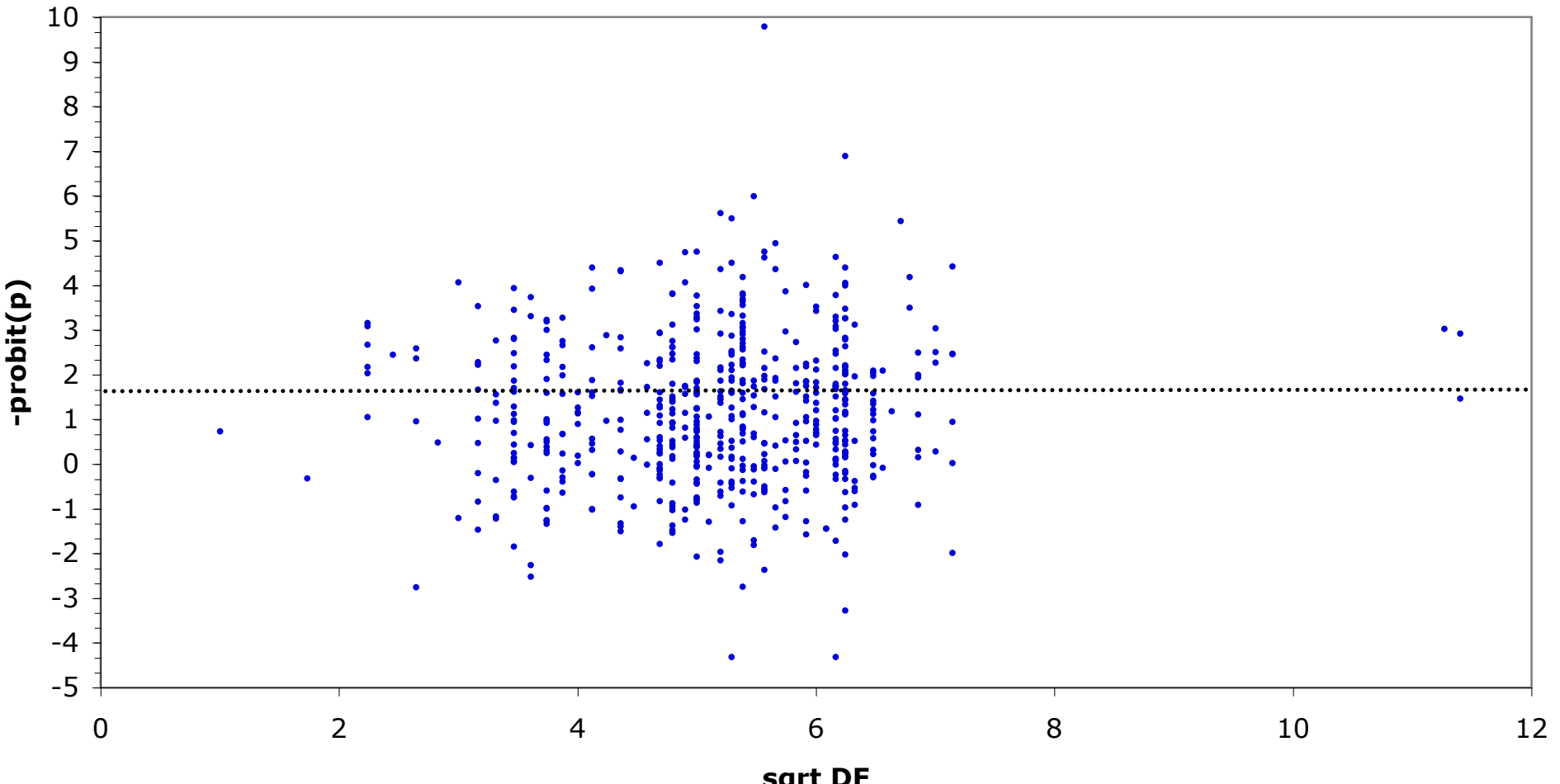
e.g. $probit(0.025) = -1.96 = -probit(0.975)$

-probit(p): Energy Causes Output



-probit(p): Output Causes Energy



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- Neat decomposition into spurious and true effects

Regression Results: Energy Causes Growth

Dependent Variable	ln|Z|	Z	-probit(p)
Constant	-0.633	0.096	-0.656
	(-1.10)	(0.18)	(-1.03)
ln DF or sqrt DF	-0.002	0.085	0.079
	(-0.02)	(1.28)	(1.00)
COEEG or COEGE	0.040	0.067	0.080
	(2.39)	(3.87)	(3.65)
CI	0.579	0.883	1.073
	(3.28)	(4.84)	(4.49)
HSIAO	0.111	0.140	0.181
	(1.13)	(1.25)	(1.25)
Adjusted R-Squared	0.053	0.129	0.111
Skewness	-2.087	0.615	-0.046
	(0.000)	(0.000)	(0.651)
Kurtosis	6.989	0.320	0.223
	(0.000)	(0.122)	(0.280)
Jarque-Bera	1568	38.21	1.388
	(0.000)	(0.000)	(0.500)

Regression Results: Growth Causes Energy

Dependent Variable	ln|Z|	Z	-probit(p)
Constant	-0.409	0.606	-0.101
	(-0.62)	(1.62)	(-0.194)
ln DF or sqrt DF	-0.032	0.078	0.070
	(-0.22)	(1.55)	(1.03)
COEEG or COEGE	0.030	0.037	0.047
	(1.61)	(2.19)	(2.13)
CI	0.564	0.714	0.893
	(2.43)	(1.07)	(2.98)
HSIAO	0.293	0.120	0.226
	(2.33)	(1.07)	(1.52)
Adjusted R-Squared	0.031	0.064	0.057
Skewness	-3.354	1.072	0.235
	(0.000)	(0.000)	(0.022)
Kurtosis	20.295	2.944	1.367
	(0.000)	(0.000)	(0.000)
Jarque-Bera	10927	317.2	49.95
	(0.000)	(0.000)	(0.000)

Testing Effects of Methodologies

- Dummy variables for methodologies:

$$-probit(p_i) = \alpha_0 + \alpha_1 DF_i^{0.5} + \alpha_2 K_i + \beta_1 d_i DF_i^{0.5} + \beta_2 d_i + v_i$$

- Test:

$$\alpha_1 + \beta_1 > 0$$

Tests for Effects of Methodologies, Variables, and Variable Definitions

Techniques								
Cointeg-ration	Short-run	Long-run	Joint	Johansen	Engle-Granger	Granger	Toda-Yamamoto	Hsiao
Energy Causes Growth								
0.180 (1.16)	0.099 (0.91)	0.848 (0.86)	0.321 (0.86)	0.200 (1.20)	-0.007 (-0.09)	0.064 (0.44)	-0.068 (-0.72)	-0.187 (-1.37)
Growth Causes Energy								
0.315 (1.85)	-0.248 (-1.46)	0.459 (3.23)	1.137 (3.97)	0.283 (1.56)	0.649 (3.76)	-0.188 (-1.44)	-0.088 (-0.56)	-0.195 (-1.20)

Tests for Effects of Methodologies, Variables, and Variable Definitions

Variables				Variable Definition	
Time	Controls	Price	Capital	Macro-macro	MM Total Energy
Energy Causes Growth					
0.190 (0.77)	-0.053 (-0.35)	-0.061 (-0.40)	-0.172 (-0.92)	0.018 (0.20)	0.107 (0.88)
Growth Causes Energy					
-0.267 (-0.78)	0.023 (0.14)	0.478 (3.15)	-0.305 (-1.81)	0.104 (1.60)	0.112 (1.17)

Conclusions

Methodological contributions:

- Controlling for over-fitting in time series models
- Probit-transform model has nice statistical properties

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- Controlling for over-fitting in time series models
- Probit-transform model has nice statistical properties

Substantive contributions:

- $G \rightarrow E$ in cointegrated VARs
- $G \rightarrow E$ in demand function model

Contact and more information:

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