Dynamic Specification Issues for Pooled Time Series Data: A General to Specific Modeling Approach

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Preliminaries

Proposition 1: Time is continuous, measurement is not.

- Social phenomena occur in continuous time.
- Social scientists measure in discrete intervals.
  - ≻ Yearly data
  - ≻ Monthly data
  - ≻ Daily data
- The sampling interval is a characteristic of the measurement, not a characteristic of the phenomenon.

Proposition 2: Frequency is often chosen for us.

- Ideally, measurement comes after theory.
- Analysts often find themselves in situations where:
  - ≻ We use data collected by others.
  - ≻ We are forced to aggregate our data or change our sampling interval to accomodate data collected by others.

Preliminaries

Proposition 3: Frequency matters.

- Intervals affect dynamics (Box-Steffensmeier et al. 2014).
- Aggregation causes information loss (Freeman 1989).
- Intervals and aggregation affect inference (Shellman 2004).

Dilemma: Experts often cannot bring their expertise to bear on some of the key features of measurement.

Question: How can analysts identify the dynamic models that best represent hypothesized relationships when they do not control how the relationships are measured?

Problem: There is a well established set of procedures for dynamic specification of single time series models, but these procedures are not being followed by time series cross section (TSCS) analysts.

The Problem of Dynamic Specification

Political scientists develop theories about X and Y, not X_t and Y_t.

Theories often lack temporal specificity (Cook and Campbell 1979).

Consider a theory about a cause (A) and an effect (B).

- If A causes B, what is the delay between A and B?
- What if B is instantaneous but fleeting?
- What if B is delayed?

Most theories are agnostic about time.

- X and Y are related over time.
- How we measure X and Y determines how we observe and test the relationship between X_t and Y_t.

Dynamic specification is influenced by measurement. We choose the specification that best fits the data.

Alternative Views of Dynamic Specification

Time is a Tool - How many lags of X?

Lags of X are sometimes used as a way to imitate exogeneity.

- Brute force approach to causal inference.
- Contemporaneous X_t is omitted to strengthen causal claims.
- X_{t-1} happens before Y_t because X_{t-1} occurred at $t-1$.

Cranmer et al. (2015) refer to this as the a-theoretic lag problem.

This approach misunderstands dynamic relationships.

- X and Y are continuous processes
- If X_t and Y_t are related, omitting X_t causes bias.
- Why one lag (PImper et al. 2005)?

Alternative Views of Dynamic Specification

Time is a Nuisance - How many lags of Y?

Lags of Y are used to "control for" serial correlation.

- A LDV is thought to purge the data of temporal correlation.
- Primary reason for y_{t-1} (Wilson and Butler 2007).

Wilkins (2017) chronicles the "To lag or not to lag?" debate.

The nuisance approach misunderstands serial correlation.

- Serial correlation is a symptom, not a disease.
- Serial correlation is a problem of specification or measurement.
- One cannot "control for" serial correlation without including a variable that explains the serial correlation.

"Correcting" the residuals may leave the model incorrect.

Alternative Views of Dynamic Specification

Time is part of my theory - I know how many lags of X and Y.

Some people have theories about dynamics.

- Intervention analysis and transfer function models
- Some DGPs are daily, monthly, or annual.

Most dynamic theories are not theories about dynamics.

Pseudo-theories are common:

- Last year *should* affect this year.
- One lag is *usually* the right model.

Does theory have any place in dynamic specification?

- Identify a feasible lag length (Cranmer et al. 2015).
- Choose a specification that encompasses your theory.
- Test restrictions to identify the best model.

A Systematic Approach to Dynamic Specification

Best Practice: The general to specific approach

- Begin with a general model
- Simplify the model using diagnostic tests
    - White noise residuals
    - Weak exogeneity
    - Encompassing rival models
- Select the best fitting congruent model

Specific to general approaches are prone to error

- Individual tests produce inconsistent results.
- The first few residuals from a misspecified model often appear to be white noise (Newbold 1972).

A General Model

The Autoregressive Distributed Lag Model - ADL(1,1)

$$y_{it} = \alpha_0 + \alpha_1 y_{it-1} + \beta_0 x_{it} + \beta_1 x_{it-1} + \varepsilon_{it}$$

Model	Abbreviation	Equation	Restriction	Motivation
Static		$y_{it} = \alpha_0 + \beta_0 x_{it} + \varepsilon_{it}$	$\alpha_1 = \beta_1 = 0$	No dynamics
Partial Adjustment	PA(1)	$y_{it} = \alpha_0 + \alpha_1 y_{it-1} + \beta_0 x_{it} + \varepsilon_{it}$	$\beta_1 = 0$	Control for serial correlation
Finite Distributed Lag	FDL(1)	$y_{it} = \alpha_0 + \beta_0 x_{it} + \beta_1 x_{it-1} + \varepsilon_{it}$	$\alpha_1 = 0$	Make x exogenous to y
Dead Start	DS(1,1)	$y_{it} = \alpha_0 + \alpha_1 y_{it-1} + \beta_1 x_{it-1} + \varepsilon_{it}$	$\beta_0 = 0$	Correlation and exogeneity

DeBoef and Keele (2008) - Table 1 (p. 287)

Dynamic Specification in TSCS Models

Why don't TSCS analysts follow best practices for TS analysis?

1. More attention to CS than TS
   - Unit heterogeneity, FE or RE? (Clark and Linzer 2015)
   - Panel heteroskedasticity (Beck and Katz 1995)
2. Common procedures have built in options for dynamic specification.
   - `xtpcse` - allows for AR(1) correlation structure.
   - `xtabond` - default is AR(1). Commonly used when CS > T.
3. TSCS tests don't perform as well as TS tests

Questions:

- How well do diagnostics perform with TSCS models?
- Can the general to specific approach work with TSCS data?

Tests for Serial Correlation

Tests for Null of No Serial Correlation with Specific Alternative Hypotheses

Author(s)	Year	Alternative Hypothesis	Journal	Citations
Bhargava et al.	1982	AR(1) Durbin-Watson	Review of Economic Studies	767
Arellano and Bond	1991	AR(2)	The Review of Econometric Studies	20931
Baltagi and Li	1995	AR(1) or MA(1)	Review of Economic Studies	192
Baltagi and Wu	1999	AR(1)	Econometric Theory	724
Bera et al.	2001	AR(1)	Journal of Econometrics	92
Wooldridge	2002	AR(1)	Econometric Theory	30892
Drukker	2003	AR(1) Wooldridge	The Stata Journal	1050

Yellow tests included in simulations.

Tests for Serial Correlation

Tests for Null of No Serial Correlation with General Alternative Hypotheses

Author(s)	Year	Test	Journal	Citations
Fu et al.	2002	Portmanteau test for pooled models	Biometrika	11
Hong and Kao	2004	General wavelet based test	Econometrica	49
Inoue and Solon	2006	Portmanteau test for fixed effects models	Econometric Theory	20
Okui	2009	Portmanteau test	Mathematics and Computers in Simulation	5
Du	2014	Permutation test for serial independence	Computational Statistics and Data Analysis	0

Yellow tests included in simulations.

Tests for Serial Correlation

We compare the highlighted tests for serial correlation.

- CS (Number of cross sections): 25, 100
- T (Number of time points): 25, 100
- DGP (α_1, β_0, β_1): Static, PA(1), FDL(1), ADL(1,1)
- Model: Static, PA(1), FDL(1), ADL(1,1)
- ρ_y : .5, .9
- ρ_x : .5, .9

The tables show the proportions of $nsim = 1,000$ where $p < .05$

The interpretation varies based on the model and the DGP

- H_0 is *true* when the model encompasses the DGP.
- H_0 is *false* otherwise

Serial Correlation Test Performance

Static Model

$CS =$	25	100	25	100	25	100	25	100
$T =$	25	25	100	100	25	25	100	100
	Static Model H_0 *True*				PA(1) Model H_0 *True*			
Okui	0.15	0.46	0.08	0.15	0.16	0.46	0.08	0.15
Wooldridge	0.08	0.05	0.08	0.05	1.00	1.00	1.00	1.00
Bhargava	0.05	0.04	0.04	0.04	0.02	0.02	0.01	0.01
Bera	0.06	0.06	0.04	0.04	0.01	0.01	0.01	0.00
	FDL(1) Model H_0 *True*				ADL(1,1) Model H_0 *True*			
Okui	0.15	0.46	0.08	0.15	0.15	0.46	0.08	0.15
Wooldridge	0.07	0.05	0.08	0.05	1.00	1.00	1.00	1.00
Bhargava	0.05	0.04	0.04	0.04	0.00	0.00	0.00	0.00
Bera	0.06	0.06	0.04	0.05	0.00	0.00	0.00	0.00

Serial Correlation Tests

$\rho_y = .5$

$CS =$	25	100	25	100	25	100	25	100
$T =$	25	25	100	100	25	25	100	100
	Static Model H_0 *False*				**PA(1) Model** H_0 *True*			
Okui	0.20	0.46	0.15	0.24	0.15	0.46	0.08	0.15
Wooldridge	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bhargava	1.00	1.00	1.00	1.00	0.03	0.02	0.01	0.02
Bera	1.00	1.00	1.00	1.00	0.03	0.02	0.02	0.01
	FDL(1) Model H_0 *False*				ADL(1,1) Model H_0 *True*			
Okui	0.21	0.46	0.15	0.23	0.15	0.46	0.08	0.15
Wooldridge	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bhargava	1.00	1.00	1.00	1.00	0.01	0.01	0.00	0.01
Bera	1.00	1.00	1.00	1.00	0.01	0.01	0.00	0.00

Serial Correlation Tests

$\rho_y = .9$

$CS =$	25	100	25	100	25	100	25	100
$T =$	25	25	100	100	25	25	100	100
	Static Model H_0 *False*				**PA(1) Model** H_0 *True*			
Okui	0.44	0.53	0.65	0.54	0.16	0.46	0.08	0.15
Wooldridge	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bhargava	1.00	1.00	1.00	1.00	0.06	0.05	0.04	0.04
Bera	1.00	1.00	1.00	1.00	0.06	0.05	0.03	0.03
	FDL(1) Model H_0 *False*				ADL(1,1) Model H_0 *True*			
Okui	0.44	0.54	0.63	0.54	0.15	0.46	0.08	0.15
Wooldridge	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bhargava	1.00	1.00	1.00	1.00	0.05	0.05	0.05	0.04
Bera	1.00	1.00	1.00	1.00	0.05	0.06	0.03	0.04

Serial Correlation Tests

$\rho_x = .5$

$CS =$	25	100	25	100	25	100	25	100
$T =$	25	25	100	100	25	25	100	100
	Static Model H_0 *False*				PA(1) Model H_0 *False*			
Okui	0.16	0.48	0.06	0.15	0.20	0.47	0.10	0.18
Wooldridge	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bhargava	0.03	0.03	0.02	0.01	0.00	0.00	0.00	0.00
Bera	0.03	0.03	0.01	0.01	1.00	1.00	1.00	1.00
	FDL(1) Model H_0 *True*				ADL(1,1) Model H_0 *True*			
Okui	0.15	0.46	0.08	0.15	0.15	0.46	0.08	0.15
Wooldridge	0.07	0.05	0.08	0.05	1.00	1.00	1.00	1.00
Bhargava	0.05	0.04	0.04	0.04	0.01	0.01	0.01	0.01
Bera	0.07	0.06	0.04	0.04	0.01	0.01	0.01	0.00

Serial Correlation Tests

$\rho_x = .9$

$CS =$	25	100	25	100	25	100	25	100
$T =$	25	25	100	100	25	25	100	100
	Static Model H_0 *False*				PA(1) Model H_0 *False*			
Okui	0.16	0.47	0.06	0.15	0.20	0.47	0.10	0.17
Wooldridge	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bhargava	0.06	0.05	0.04	0.04	0.00	0.00	0.00	0.00
Bera	0.05	0.07	0.04	0.04	1.00	1.00	1.00	1.00
	FDL(1) Model H_0 *True*				ADL(1,1) Model H_0 *True*			
Okui	0.16	0.46	0.08	0.15	0.15	0.46	0.08	0.15
Wooldridge	0.07	0.05	0.08	0.05	1.00	1.00	1.00	1.00
Bhargava	0.05	0.04	0.04	0.04	0.01	0.01	0.01	0.01
Bera	0.06	0.06	0.04	0.04	0.01	0.01	0.01	0.01

Serial Correlation Tests

$\rho_x = .5 \ \rho_y = .5$

$CS =$	25	100	25	100	25	100	25	100
$T =$	25	25	100	100	25	25	100	100
	Static Model H_0 *False*				PA(1) Model H_0 *False*			
Okui	0.19	0.46	0.14	0.23	0.19	0.47	0.07	0.16
Wooldridge	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bhargava	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00
Bera	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	FDL(1) Model H_0 *False*				**ADL(1,1) Model** H_0 *True*			
Okui	0.18	0.45	0.14	0.23	0.15	0.46	0.08	0.15
Wooldridge	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bhargava	1.00	1.00	1.00	1.00	0.03	0.04	0.04	0.04
Bera	1.00	1.00	1.00	1.00	0.04	0.04	0.03	0.03

Serial Correlation Tests

$\rho_x = .9 \ \rho_y = .9$

$CS =$	25	100	25	100	25	100	25	100
$T =$	25	25	100	100	25	25	100	100
	Static Model H_0 *False*				PA(1) Model H_0 *False*			
Okui	0.49	0.58	0.60	0.55	0.17	0.47	0.06	0.16
Wooldridge	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bhargava	1.00	1.00	1.00	1.00	0.01	0.00	0.00	0.00
Bera	1.00	1.00	1.00	1.00	0.04	0.06	0.09	0.27
	FDL(1) Model H_0 *False*				**ADL(1,1) Model** H_0 *True*			
Okui	0.50	0.59	0.59	0.55	0.15	0.46	0.08	0.15
Wooldridge	1.00	1.00	1.00	1.00	0.70	1.00	0.99	1.00
Bhargava	1.00	1.00	1.00	1.00	0.05	0.05	0.05	0.05
Bera	1.00	1.00	1.00	1.00	0.07	0.06	0.04	0.04

Serial Correlation Tests

Conclusions

Bhargava et al. (1982) - Performs well in most cases.

- Does not detect serial correlation in PA(1) model when x_{t-1} should be included in the model.

Bera et al. (2001) - Performs well in many cases.

- Does not detect serial correlation in the static model when x_{t-1} should be included in the model.
- Performance is inconsistent for ADL(1,1).

Wooldridge (2003) - prone to reject the null.

Okui (2009) - Performs best when $T > CS$.

- Never reaches appropriate rejection rates, and performs poorly most of the time.

Serial Correlation Tests

Conclusions

		H_0 True			H_0 False		
Model		Success Rate	$< 5\%$	Total	Success Rate	$> 95\%$	Total
Static		50%	32	64	100%	0	0
PA (1)	$\rho_y = .5$	50%	16	32	75%	24	32
PA (1)	$\rho_y = .9$	41%	13	32	75%	24	32
FDL (1)	$\rho_x = .5$	50%	16	32	38%	12	32
FDL (1)	$\rho_x = .9$	50%	16	32	38%	12	32
ADL (1,1)	$\rho_x = \rho_y = .5$	50%	8	16	67%	32	48
ADL (1,1)	$\rho_x = \rho_y = .9$	38%	6	16	58%	28	48
Total		48 %	107	224	59%	132	224

Information Criteria

We compare information criteria as tools for model selection.

- Akaike information criterion (AIC)
- Bayesian information criterion (BIC)

How often do these information criteria select the correct model?

- The AIC and BIC are calculated for each model.
- The minimum AIC and BIC are selected for each iteration.
- The name of the associated model is stored.
- Again, $nsim = 1000$

The tables show the percentage of cases where the information criteria selected the appropriate model for a given DGP.

Information Criteria

Static Model

	CS	T	Percent AIC Correct	AIC Mode Model	Percent Mode Model	Percent BIC Correct	BIC Mode Model	Proportion Mode Model
Static	25	25	62.6%	Static	62.6%	0.00%	FDL(1)	77.2%
	100	25	61.7%	Static	61.7%	0.00%	FDL(1)	78.4%
	25	100	63.7%	Static	63.7%	0.00%	FDL(1)	79.0%
	100	100	60.4%	Static	60.4%	0.00%	FDL(1)	80.0%

Information Criteria

PA(1)

	CS	T	Percent AIC Correct	AIC Mode Model	Percent Mode Model	Percent BIC Correct	BIC Mode Model	Proportion Mode Model
$\rho_y = .5$	25	25	61.7%	PA(1)	61.7%	97.3%	PA(1)	97.3%
	100	25	63.2%	PA(1)	63.2%	98.9%	PA(1)	98.9%
	25	100	62.7%	PA(1)	62.7%	99.4%	PA(1)	99.4%
	100	100	63.2%	PA(1)	63.2%	99.6%	PA(1)	99.6%
$\rho_y = .9$	25	25	63.9%	PA(1)	63.9%	97.9%	PA(1)	97.9%
	100	25	62.4%	PA(1)	62.4%	99.0%	PA(1)	99.0%
	25	100	63.5%	PA(1)	63.5%	99.1%	PA(1)	99.1%
	100	100	62.7%	PA(1)	62.7%	99.1%	PA(1)	99.1%

Information Criteria

FDL(1)

	CS	T	Percent AIC Correct	AIC Mode Model	Percent Mode Model	Percent BIC Correct	BIC Mode Model	Proportion Mode Model
$\rho_x = .5$	25	25	62.2%	FDL(1)	62.2%	78.3%	FDL(1)	78.3%
	100	25	64.3%	FDL(1)	64.3%	79.7%	FDL(1)	79.7%
	25	100	62.1%	FDL(1)	62.1%	77.5%	FDL(1)	77.5%
	100	100	61.1%	FDL(1)	61.1%	78.2%	FDL(1)	78.2%
$\rho_x = .9$	25	25	64.6%	FDL(1)	64.6%	79.7%	FDL(1)	79.7%
	100	25	62.9%	FDL(1)	62.9%	78.5%	FDL(1)	78.5%
	25	100	63.7%	FDL(1)	63.7%	78.7%	FDL(1)	78.7%
	100	100	63.7%	FDL(1)	63.7%	78.2%	FDL(1)	78.2%

Information Criteria

ADL(1,1)

	CS	T	Percent AIC Correct	AIC Mode Model	Percent Mode Model	Percent BIC Correct	BIC Mode Model	Proportion Mode Model
$\rho_x = \rho y = .5$	25	25	63.8%	ADL(1,1)	63.8%	97.9%	ADL(1,1)	97.9%
	100	25	66.2%	ADL(1,1)	66.2%	99.1%	ADL(1,1)	99.1%
	25	100	63.5%	ADL(1,1)	63.5%	99.0%	ADL(1,1)	99.0%
	100	100	62.3%	ADL(1,1)	62.3%	99.4%	ADL(1,1)	99.4%
$\rho_x = \rho y = .9$	25	25	65.7%	ADL(1,1)	65.7%	97.7%	ADL(1,1)	97.7%
	100	25	64.1%	ADL(1,1)	64.1%	98.8%	ADL(1,1)	98.8%
	25	100	64.6%	ADL(1,1)	64.6%	99.4%	ADL(1,1)	99.4%
	100	100	64.7%	ADL(1,1)	64.7%	99.6%	ADL(1,1)	99.6%

Information criteria are more reliable than serial correlation tests.

Akaike information criterion

- The AIC selected the correct model most of the time.
- The modal model for the AIC was always the correct model.

Bayesian information criterion (BIC)

- The BIC selected the FDL(1) model for the static DGP.
- The BIC selected the correct model most of the time.
- The BIC performed best (95 % +) when $\alpha_1 \neq 0$

Comparing Dynamic Specification Strategies

Specification Strategy	Correlation Tests	Information Criteria	Termination Criteria
Theory	X		No serial correlation
y_{t-1} to "control for" serial correlation	X		No serial correlation
x_{t-1} to impose exogeneity	X		No serial correlation
Combine 2 and 3	X		No serial correlation
Specific to general	X	X	Build until no serial correlation
General to specific	X	X	Sufficient and best fit
Compare all models	X	X	Sufficient and best fit

ADL(1,1) $\rho_y = .9$, $\rho_x = .9$, CS = 25, T = 25

Example comparison of specification strategies

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.49	1.00	1.00	1.00	5299.89	5313.20
PA(1)	0.17	1.00	0.01	0.04	2142.78	2160.53
PA(2)	0.20	1.00	0.00	1.00	1970.06	1992.25
PA(3)	0.20	1.00	0.00	1.00	1970.89	1997.52
FDL(1)	0.50	1.00	1.00	1.00	5136.02	5153.77
FDL(2)	0.51	1.00	1.00	1.00	4968.09	4990.28
FDL(3)	0.50	1.00	1.00	1.00	4797.67	4824.30
DS(1,1)	0.12	1.00	0.04	0.03	2211.28	2229.04
DS(1,2)	0.12	1.00	0.04	0.03	2211.71	2233.90
DS(1,3)	0.12	1.00	0.01	0.00	2212.24	2238.87
DS(2,1)	0.12	1.00	0.02	0.01	2211.28	2229.04
DS(2,2)	0.12	1.00	0.00	0.00	2211.71	2233.90
DS(2,3)	0.13	1.00	0.00	0.00	2212.24	2238.87
DS(3,1)	0.12	1.00	0.02	0.01	2211.28	2229.04
DS(3,2)	0.12	1.00	0.00	0.00	2213.31	2244.38
DS(3,3)	0.13	1.00	0.00	0.00	2214.74	2250.25
ADL(1,1)	0.15	0.70	0.05	0.07	1780.59	1802.78
ADL(1,2)	0.16	0.87	0.05	0.06	1781.17	1807.80
ADL(1,3)	0.16	0.95	0.06	0.07	1782.39	1813.46
ADL(2,1)	0.15	1.00	0.00	0.00	1780.59	1802.78
ADL(2,2)	0.15	1.00	0.00	0.00	1782.73	1813.80
ADL(2,3)	0.15	1.00	0.00	0.00	1783.53	1819.04
ADL(3,1)	0.15	1.00	0.00	0.00	1782.48	1813.54
ADL(3,2)	0.15	1.00	0.00	0.00	1783.50	1819.01
ADL(3,3)	0.15	1.00	0.00	0.00	1784.19	1824.13

ADL(1,1) $\rho_y = .9$, $\rho_x = .9$, CS = 25, T = 25

Include y_{t-1} to control for serial correlation

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.49	1.00	1.00	1.00	5299.89	5313.20
PA(1)	0.17	1.00	0.01	0.04	2142.78	2160.53
PA(2)	0.20	1.00	0.00	1.00	1970.06	1992.25
PA(3)	0.20	1.00	0.00	1.00	1970.89	1997.52
FDL(1)	0.50	1.00	1.00	1.00	5136.02	5153.77
FDL(2)	0.51	1.00	1.00	1.00	4968.09	4990.28
FDL(3)	0.50	1.00	1.00	1.00	4797.67	4824.30
DS(1,1)	0.12	1.00	0.04	0.03	2211.28	2229.04
DS(1,2)	0.12	1.00	0.04	0.03	2211.71	2233.90
DS(1,3)	0.12	1.00	0.01	0.00	2212.24	2238.87
DS(2,1)	0.12	1.00	0.02	0.01	2211.28	2229.04
DS(2,2)	0.12	1.00	0.00	0.00	2211.71	2233.90
DS(2,3)	0.13	1.00	0.00	0.00	2212.24	2238.87
DS(3,1)	0.12	1.00	0.02	0.01	2211.28	2229.04
DS(3,2)	0.12	1.00	0.00	0.00	2213.31	2244.38
DS(3,3)	0.13	1.00	0.00	0.00	2214.74	2250.25
ADL(1,1)	0.15	0.70	0.05	0.07	1780.59	1802.78
ADL(1,2)	0.16	0.87	0.05	0.06	1781.17	1807.80
ADL(1,3)	0.16	0.95	0.06	0.07	1782.39	1813.46
ADL(2,1)	0.15	1.00	0.00	0.00	1780.59	1802.78
ADL(2,2)	0.15	1.00	0.00	0.00	1782.73	1813.80
ADL(2,3)	0.15	1.00	0.00	0.00	1783.53	1819.04
ADL(3,1)	0.15	1.00	0.00	0.00	1782.48	1813.54
ADL(3,2)	0.15	1.00	0.00	0.00	1783.50	1819.01
ADL(3,3)	0.15	1.00	0.00	0.00	1784.19	1824.13

ADL(1,1) $\rho_y = .9$, $\rho_x = .9$, CS = 25, T = 25

Include x_{t-1} to max x exogenous to y

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.49	1.00	1.00	1.00	5299.89	5313.20
PA(1)	0.17	1.00	0.01	0.04	2142.78	2160.53
PA(2)	0.20	1.00	0.00	1.00	1970.06	1992.25
PA(3)	0.20	1.00	0.00	1.00	1970.89	1997.52
FDL(1)	0.50	1.00	1.00	1.00	5136.02	5153.77
FDL(2)	0.51	1.00	1.00	1.00	4968.09	4990.28
FDL(3)	0.50	1.00	1.00	1.00	4797.67	4824.30
DS(1,1)	0.12	1.00	0.04	0.03	2211.28	2229.04
DS(1,2)	0.12	1.00	0.04	0.03	2211.71	2233.90
DS(1,3)	0.12	1.00	0.01	0.00	2212.24	2238.87
DS(2,1)	0.12	1.00	0.02	0.01	2211.28	2229.04
DS(2,2)	0.12	1.00	0.00	0.00	2211.71	2233.90
DS(2,3)	0.13	1.00	0.00	0.00	2212.24	2238.87
DS(3,1)	0.12	1.00	0.02	0.01	2211.28	2229.04
DS(3,2)	0.12	1.00	0.00	0.00	2213.31	2244.38
DS(3,3)	0.13	1.00	0.00	0.00	2214.74	2250.25
ADL(1,1)	0.15	0.70	0.05	0.07	1780.59	1802.78
ADL(1,2)	0.16	0.87	0.05	0.06	1781.17	1807.80
ADL(1,3)	0.16	0.95	0.06	0.07	1782.39	1813.46
ADL(2,1)	0.15	1.00	0.00	0.00	1780.59	1802.78
ADL(2,2)	0.15	1.00	0.00	0.00	1782.73	1813.80
ADL(2,3)	0.15	1.00	0.00	0.00	1783.53	1819.04
ADL(3,1)	0.15	1.00	0.00	0.00	1782.48	1813.54
ADL(3,2)	0.15	1.00	0.00	0.00	1783.50	1819.01
ADL(3,3)	0.15	1.00	0.00	0.00	1784.19	1824.13

ADL(1,1) $\rho_y = .9$, $\rho_x = .9$, CS = 25, T = 25

Include y_{t-1} to control for serial correlation *and* x_{t-1} to max x exogenous to y

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.49	1.00	1.00	1.00	5299.89	5313.20
PA(1)	0.17	1.00	0.01	0.04	2142.78	2160.53
PA(2)	0.20	1.00	0.00	1.00	1970.06	1992.25
PA(3)	0.20	1.00	0.00	1.00	1970.89	1997.52
FDL(1)	0.50	1.00	1.00	1.00	5136.02	5153.77
FDL(2)	0.51	1.00	1.00	1.00	4968.09	4990.28
FDL(3)	0.50	1.00	1.00	1.00	4797.67	4824.30
DS(1,1)	0.12	1.00	0.04	0.03	2211.28	2229.04
DS(1,2)	0.12	1.00	0.04	0.03	2211.71	2233.90
DS(1,3)	0.12	1.00	0.01	0.00	2212.24	2238.87
DS(2,1)	0.12	1.00	0.02	0.01	2211.28	2229.04
DS(2,2)	0.12	1.00	0.00	0.00	2211.71	2233.90
DS(2,3)	0.13	1.00	0.00	0.00	2212.24	2238.87
DS(3,1)	0.12	1.00	0.02	0.01	2211.28	2229.04
DS(3,2)	0.12	1.00	0.00	0.00	2213.31	2244.38
DS(3,3)	0.13	1.00	0.00	0.00	2214.74	2250.25
ADL(1,1)	0.15	0.70	0.05	0.07	1780.59	1802.78
ADL(1,2)	0.16	0.87	0.05	0.06	1781.17	1807.80
ADL(1,3)	0.16	0.95	0.06	0.07	1782.39	1813.46
ADL(2,1)	0.15	1.00	0.00	0.00	1780.59	1802.78
ADL(2,2)	0.15	1.00	0.00	0.00	1782.73	1813.80
ADL(2,3)	0.15	1.00	0.00	0.00	1783.53	1819.04
ADL(3,1)	0.15	1.00	0.00	0.00	1782.48	1813.54
ADL(3,2)	0.15	1.00	0.00	0.00	1783.50	1819.01
ADL(3,3)	0.15	1.00	0.00	0.00	1784.19	1824.13

ADL(1,1) $\rho_y = .9$, $\rho_x = .9$, CS = 25, T = 25

Build from a specific model to a general model

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.49	1.00	1.00	1.00	5299.89	5313.20
PA(1)	0.17	1.00	0.01	0.04	2142.78	2160.53
PA(2)	0.20	1.00	0.00	1.00	1970.06	1992.25
PA(3)	0.20	1.00	0.00	1.00	1970.89	1997.52
FDL(1)	0.50	1.00	1.00	1.00	5136.02	5153.77
FDL(2)	0.51	1.00	1.00	1.00	4968.09	4990.28
FDL(3)	0.50	1.00	1.00	1.00	4797.67	4824.30
DS(1,1)	0.12	1.00	0.04	0.03	2211.28	2229.04
DS(1,2)	0.12	1.00	0.04	0.03	2211.71	2233.90
DS(1,3)	0.12	1.00	0.01	0.00	2212.24	2238.87
DS(2,1)	0.12	1.00	0.02	0.01	2211.28	2229.04
DS(2,2)	0.12	1.00	0.00	0.00	2211.71	2233.90
DS(2,3)	0.13	1.00	0.00	0.00	2212.24	2238.87
DS(3,1)	0.12	1.00	0.02	0.01	2211.28	2229.04
DS(3,2)	0.12	1.00	0.00	0.00	2213.31	2244.38
DS(3,3)	0.13	1.00	0.00	0.00	2214.74	2250.25
ADL(1,1)	0.15	0.70	0.05	0.07	1780.59	1802.78
ADL(1,2)	0.16	0.87	0.05	0.06	1781.17	1807.80
ADL(1,3)	0.16	0.95	0.06	0.07	1782.39	1813.46
ADL(2,1)	0.15	1.00	0.00	0.00	1780.59	1802.78
ADL(2,2)	0.15	1.00	0.00	0.00	1782.73	1813.80
ADL(2,3)	0.15	1.00	0.00	0.00	1783.53	1819.04
ADL(3,1)	0.15	1.00	0.00	0.00	1782.48	1813.54
ADL(3,2)	0.15	1.00	0.00	0.00	1783.50	1819.01
ADL(3,3)	0.15	1.00	0.00	0.00	1784.19	1824.13

ADL(1,1) $\rho_y = .9$, $\rho_x = .9$, CS = 25, T = 25

Test from a general model to a specific model *or* estimate all models and compare

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.49	1.00	1.00	1.00	5299.89	5313.20
PA(1)	0.17	1.00	0.01	0.04	2142.78	2160.53
PA(2)	0.20	1.00	0.00	1.00	1970.06	1992.25
PA(3)	0.20	1.00	0.00	1.00	1970.89	1997.52
FDL(1)	0.50	1.00	1.00	1.00	5136.02	5153.77
FDL(2)	0.51	1.00	1.00	1.00	4968.09	4990.28
FDL(3)	0.50	1.00	1.00	1.00	4797.67	4824.30
DS(1,1)	0.12	1.00	0.04	0.03	2211.28	2229.04
DS(1,2)	0.12	1.00	0.04	0.03	2211.71	2233.90
DS(1,3)	0.12	1.00	0.01	0.00	2212.24	2238.87
DS(2,1)	0.12	1.00	0.02	0.01	2211.28	2229.04
DS(2,2)	0.12	1.00	0.00	0.00	2211.71	2233.90
DS(2,3)	0.13	1.00	0.00	0.00	2212.24	2238.87
DS(3,1)	0.12	1.00	0.02	0.01	2211.28	2229.04
DS(3,2)	0.12	1.00	0.00	0.00	2213.31	2244.38
DS(3,3)	0.13	1.00	0.00	0.00	2214.74	2250.25
ADL(1,1)	0.15	0.70	0.05	0.07	1780.59	1802.78
ADL(1,2)	0.16	0.87	0.05	0.06	1781.17	1807.80
ADL(1,3)	0.16	0.95	0.06	0.07	1782.39	1813.46
ADL(2,1)	0.15	1.00	0.00	0.00	1780.59	1802.78
ADL(2,2)	0.15	1.00	0.00	0.00	1782.73	1813.80
ADL(2,3)	0.15	1.00	0.00	0.00	1783.53	1819.04
ADL(3,1)	0.15	1.00	0.00	0.00	1782.48	1813.54
ADL(3,2)	0.15	1.00	0.00	0.00	1783.50	1819.01
ADL(3,3)	0.15	1.00	0.00	0.00	1784.19	1824.13

Comparing Specification Strategies

ADL(1,1)

Model		CS	T	Serial Correlation	Exogeneity	Both	Specific to General	General to Specific	All Models
ADL(1,1)	$\rho_y = \rho_x = .5$	25	25	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .5$	100	25	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .5$	25	100	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .5$	100	100	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .9$	25	25	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .9$	100	25	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .9$	25	100	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .9$	100	100	Fail	Success	Fail	Fail	Success	Success

Comparing Specification Strategies
ADL(1,1)

Model		CS	T	Serial Correlation	Exogeneity	Both	Specific to General	General to Specific	All Models
ADL(1,1)	$\rho_y = \rho_x = .5$	25	25	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .5$	100	25	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .5$	25	100	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .5$	100	100	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .9$	25	25	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .9$	100	25	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .9$	25	100	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .9$	100	100	Fail	Success	Fail	Fail	Success	Success

Comparing Specification Strategies

ADL(1,1)

Model		CS	T	Serial Correlation	Exogeneity	Both	Specific to General	General to Specific	All Models
ADL(1,1)	$\rho_y = \rho_x = .5$	25	25	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .5$	100	25	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .5$	25	100	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .5$	100	100	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .9$	25	25	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .9$	100	25	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .9$	25	100	Fail	Success	Fail	Fail	Success	Success
ADL(1,1)	$\rho_y = \rho_x = .9$	100	100	Fail	Success	Fail	Fail	Success	Success

Comparing Specification Strategies

PA(1)

Model		CS	T	Serial Correlation	Exogeneity	Both	Specific to General	General to Specific	All Models
PA(1)	$\rho_y = .5$	25	25	Success	Success	Fail	Success	Success	Success
PA(1)	$\rho_y = .5$	100	25	Success	Success	Fail	Success	Success	Success
PA(1)	$\rho_y = .5$	25	100	Success	Success	Fail	Success	Success	Success
PA(1)	$\rho_y = .5$	100	100	Success	Success	Fail	Success	Success	Success
PA(1)	$\rho_y = .9$	25	25	Success	Success	Fail	Success	Success	Success
PA(1)	$\rho_y = .9$	100	25	Success	Success	Fail	Success	Success	Success
PA(1)	$\rho_y = .9$	25	100	Success	Success	Fail	Success	Success	Success
PA(1)	$\rho_y = .9$	100	100	Success	Success	Fail	Success	Success	Success

Comparing Specification Strategies

FDL(1)

Model		CS	T	Serial Correlation	Exogeneity	Both	Specific to General	General to Specific	All Models
FDL(1)	$\rho_x = .5$	25	25	Fail	Success	Fail	Fail	Success	Success
FDL(1)	$\rho_x = .5$	100	25	Fail	Success	Fail	Fail	Success	Success
FDL(1)	$\rho_x = .5$	25	100	Fail	Success	Fail	Fail	Success	Success
FDL(1)	$\rho_x = .5$	100	100	Fail	Success	Fail	Fail	Success	Success
FDL(1)	$\rho_x = .9$	25	25	Fail	Success	Fail	Fail	Success	Success
FDL(1)	$\rho_x = .9$	100	25	Fail	Success	Fail	Fail	Success	Success
FDL(1)	$\rho_x = .9$	25	100	Fail	Success	Fail	Fail	Success	Success
FDL(1)	$\rho_x = .9$	100	100	Fail	Success	Fail	Fail	Success	Success

Conclusions

Even though individual TSCS tests for serial correlation are unreliable, the best practices used for dynamic specification of single time series models can be used for TSCS models.

The General to specific modeling strategy outperforms common approaches to specification of TSCS models.

Estimating and comparing all feasible models is a workable alternative approach.

Specification questions moving forward

- Unit heterogeneity
- Cross sectional dynamic heterogeneity
- Binary time series cross section models
- Panel unit root tests

Thank You

PA(1) $\rho_y = .5$, CS = 25, T = 25

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.20	1.00	1.00	1.00	2093.44	2106.75
PA(1)	0.15	1.00	0.03	0.03	1779.44	1797.19
PA(2)	0.15	1.00	0.02	0.01	1780.33	1802.52
PA(3)	0.15	1.00	0.02	0.01	1781.50	1808.13
FDL(1)	0.21	1.00	1.00	1.00	1993.31	2011.07
FDL(2)	0.20	1.00	1.00	1.00	1966.00	1988.18
FDL(3)	0.20	1.00	1.00	1.00	1960.06	1986.69
DS(1,1)	0.12	1.00	0.00	0.00	2210.78	2228.53
DS(1,2)	0.13	1.00	0.00	0.00	2211.51	2233.70
DS(1,3)	0.12	1.00	0.00	0.00	2212.01	2238.64
DS(2,1)	0.12	1.00	0.00	0.00	2210.78	2228.53
DS(2,2)	0.12	1.00	0.00	0.00	2211.51	2233.70
DS(2,3)	0.13	1.00	0.00	0.00	2212.01	2238.64
DS(3,1)	0.12	1.00	0.00	0.00	2210.78	2228.53
DS(3,2)	0.12	1.00	0.00	0.00	2213.49	2244.56
DS(3,3)	0.13	1.00	0.00	0.00	2214.41	2249.91
ADL(1,1)	0.15	1.00	0.01	0.01	1780.61	1802.80
ADL(1,2)	0.15	1.00	0.00	0.01	1781.31	1807.94
ADL(1,3)	0.15	1.00	0.00	0.00	1781.83	1812.89
ADL(2,1)	0.15	1.00	0.00	0.00	1780.61	1802.80
ADL(2,2)	0.15	1.00	0.00	0.00	1781.84	1812.91
ADL(2,3)	0.15	1.00	0.00	0.00	1782.61	1818.11
ADL(3,1)	0.14	1.00	0.00	0.00	1782.75	1813.81
ADL(3,2)	0.15	1.00	0.00	0.00	1783.16	1818.66
ADL(3,3)	0.15	1.00	0.00	0.00	1784.02	1823.96

PA(1) $\rho_y = .5$, CS = 100, T = 25

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.46	1.00	1.00	1.00	8368.77	8386.24
PA(1)	0.46	1.00	0.02	0.02	7097.22	7120.51
PA(2)	0.46	1.00	0.02	0.01	7097.90	7127.02
PA(3)	0.46	1.00	0.02	0.01	7098.94	7133.88
FDL(1)	0.46	1.00	1.00	1.00	7966.53	7989.82
FDL(2)	0.47	1.00	1.00	1.00	7853.43	7882.55
FDL(3)	0.46	1.00	1.00	1.00	7825.42	7860.36
DS(1,1)	0.46	1.00	0.00	0.00	8832.65	8855.94
DS(1,2)	0.46	1.00	0.00	0.00	8833.86	8862.98
DS(1,3)	0.46	1.00	0.00	0.00	8834.65	8869.59
DS(2,1)	0.46	1.00	0.00	0.00	8832.65	8855.94
DS(2,2)	0.46	1.00	0.00	0.00	8833.86	8862.98
DS(2,3)	0.46	1.00	0.00	0.00	8834.65	8869.59
DS(3,1)	0.46	1.00	0.00	0.00	8832.65	8855.94
DS(3,2)	0.47	1.00	0.00	0.00	8835.94	8876.71
DS(3,3)	0.47	1.00	0.00	0.00	8836.89	8883.49
ADL(1,1)	0.46	1.00	0.01	0.01	7098.04	7127.16
ADL(1,2)	0.46	1.00	0.00	0.00	7099.25	7134.19
ADL(1,3)	0.46	1.00	0.00	0.00	7100.21	7140.97
ADL(2,1)	0.46	1.00	0.00	0.00	7098.04	7127.16
ADL(2,2)	0.46	1.00	0.00	0.00	7100.33	7141.10
ADL(2,3)	0.46	1.00	0.00	0.00	7101.24	7147.83
ADL(3,1)	0.46	1.00	0.00	0.00	7100.61	7141.38
ADL(3,2)	0.46	1.00	0.00	0.00	7101.34	7147.93
ADL(3,3)	0.46	1.00	0.00	0.00	7102.06	7154.47

PA(1) $\rho_y = .5$, CS = 25, T = 100

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.15	1.00	1.00	1.00	33489.35	8396.12
PA(1)	0.08	1.00	0.01	0.02	7100.03	7123.33
PA(2)	0.08	1.00	0.01	0.01	7101.06	7130.18
PA(3)	0.08	1.00	0.01	0.01	7102.10	7137.04
FDL(1)	0.15	1.00	1.00	1.00	7974.39	7997.69
FDL(2)	0.14	1.00	1.00	1.00	7862.22	7891.34
FDL(3)	0.14	1.00	1.00	1.00	7833.58	7868.52
DS(1,1)	0.07	1.00	0.00	0.00	8834.23	8857.53
DS(1,2)	0.07	1.00	0.00	0.00	8834.87	8863.99
DS(1,3)	0.07	1.00	0.00	0.00	8835.23	8870.17
DS(2,1)	0.06	1.00	0.00	0.00	8834.23	8857.53
DS(2,2)	0.06	1.00	0.00	0.00	8834.87	8863.99
DS(2,3)	0.06	1.00	0.00	0.00	8835.23	8870.17
DS(3,1)	0.06	1.00	0.00	0.00	8834.23	8857.53
DS(3,2)	0.07	1.00	0.00	0.00	8837.07	8877.84
DS(3,3)	0.07	1.00	0.00	0.00	8837.95	8884.54
ADL(1,1)	0.08	1.00	0.00	0.00	7101.20	7130.32
ADL(1,2)	0.08	1.00	0.00	0.00	7101.87	7136.81
ADL(1,3)	0.08	1.00	0.00	0.00	7102.35	7143.12
ADL(2,1)	0.08	1.00	0.00	0.00	7101.20	7130.32
ADL(2,2)	0.08	1.00	0.00	0.00	7103.14	7143.91
ADL(2,3)	0.08	1.00	0.00	0.00	7103.67	7150.26
ADL(3,1)	0.08	1.00	0.00	0.00	7102.75	7143.52
ADL(3,2)	0.08	1.00	0.00	0.00	7103.88	7150.48
ADL(3,3)	0.08	1.00	0.00	0.00	7104.87	7157.29

PA(1) $\rho_y = .5$, CS = 100, T = 100

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.24	1.00	1.00	1.00	33489.35	33510.98
PA(1)	0.15	1.00	0.02	0.01	28379.45	28408.29
PA(2)	0.15	1.00	0.01	0.00	28381.29	28417.35
PA(3)	0.15	1.00	0.01	0.00	28381.50	28424.76
FDL(1)	0.23	1.00	1.00	1.00	31873.40	31902.24
FDL(2)	0.23	1.00	1.00	1.00	31421.26	31457.31
FDL(3)	0.22	1.00	1.00	1.00	31307.97	31351.23
DS(1,1)	0.17	1.00	0.00	0.00	35315.88	35344.72
DS(1,2)	0.17	1.00	0.00	0.00	35316.96	35353.01
DS(1,3)	0.17	1.00	0.00	0.00	35318.56	35361.82
DS(2,1)	0.17	1.00	0.00	0.00	35315.88	35344.72
DS(2,2)	0.17	1.00	0.00	0.00	35316.96	35353.01
DS(2,3)	0.17	1.00	0.00	0.00	35318.56	35361.82
DS(3,1)	0.17	1.00	0.00	0.00	35315.88	35344.72
DS(3,2)	0.17	1.00	0.00	0.00	35318.22	35368.69
DS(3,3)	0.17	1.00	0.00	0.00	35319.83	35377.51
ADL(1,1)	0.15	1.00	0.01	0.00	28380.45	28416.50
ADL(1,2)	0.15	1.00	0.00	0.00	28381.89	28425.15
ADL(1,3)	0.15	1.00	0.00	0.00	28382.46	28432.94
ADL(2,1)	0.15	1.00	0.00	0.00	28380.45	28416.50
ADL(2,2)	0.15	1.00	0.00	0.00	28382.66	28433.13
ADL(2,3)	0.15	1.00	0.00	0.00	28384.06	28441.74
ADL(3,1)	0.15	1.00	0.00	0.00	28382.39	28432.86
ADL(3,2)	0.15	1.00	0.00	0.00	28383.85	28441.53
ADL(3,3)	0.15	1.00	0.00	0.00	28385.17	28450.06

PA(1) $\rho_y = .9$, CS = 25, T = 25

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.44	1.00	1.00	1.00	3101.75	3115.06
PA(1)	0.16	1.00	0.06	0.06	1779.62	1797.37
PA(2)	0.16	1.00	0.01	0.01	1780.76	1802.95
PA(3)	0.16	1.00	0.01	0.01	1781.34	1807.97
FDL(1)	0.44	1.00	1.00	1.00	3040.79	3058.54
FDL(2)	0.45	1.00	1.00	1.00	2987.39	3009.58
FDL(3)	0.45	1.00	1.00	1.00	2940.09	2966.72
DS(1,1)	0.12	1.00	0.01	0.01	2210.72	2228.47
DS(1,2)	0.12	1.00	0.00	0.00	2211.57	2233.76
DS(1,3)	0.12	1.00	0.00	0.00	2212.56	2239.19
DS(2,1)	0.12	1.00	0.02	0.01	2210.72	2228.47
DS(2,2)	0.12	1.00	0.00	0.00	2211.57	2233.76
DS(2,3)	0.13	1.00	0.00	0.00	2212.56	2239.19
DS(3,1)	0.11	1.00	0.01	0.01	2210.72	2228.47
DS(3,2)	0.12	1.00	0.00	0.00	2213.37	2244.43
DS(3,3)	0.13	1.00	0.00	0.00	2214.48	2249.98
ADL(1,1)	0.15	1.00	0.05	0.05	1780.76	1802.95
ADL(1,2)	0.15	1.00	0.05	0.05	1781.72	1808.35
ADL(1,3)	0.16	1.00	0.05	0.05	1782.18	1813.25
ADL(2,1)	0.15	1.00	0.00	0.00	1780.76	1802.95
ADL(2,2)	0.15	1.00	0.00	0.00	1782.64	1813.70
ADL(2,3)	0.15	1.00	0.00	0.00	1783.03	1818.53
ADL(3,1)	0.15	1.00	0.00	0.00	1782.72	1813.79
ADL(3,2)	0.15	1.00	0.00	0.00	1783.05	1818.56
ADL(3,3)	0.15	1.00	0.00	0.00	1784.01	1823.95

PA(1) $\rho_y = .9$, CS = 100, T = 25

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.53	1.00	1.00	1.00	12450.76	12468.23
PA(1)	0.46	1.00	0.05	0.05	7097.25	7120.54
PA(2)	0.46	1.00	0.02	0.01	7097.84	7126.96
PA(3)	0.47	1.00	0.02	0.01	7098.66	7133.61
FDL(1)	0.54	1.00	1.00	1.00	12205.95	12229.24
FDL(2)	0.54	1.00	1.00	1.00	11986.98	12016.10
FDL(3)	0.55	1.00	1.00	1.00	11789.87	11824.81
DS(1,1)	0.46	1.00	0.01	0.01	8833.01	8856.30
DS(1,2)	0.46	1.00	0.00	0.00	8833.97	8863.09
DS(1,3)	0.46	1.00	0.00	0.00	8834.72	8869.67
DS(2,1)	0.46	1.00	0.01	0.01	8833.01	8856.30
DS(2,2)	0.46	1.00	0.00	0.00	8833.97	8863.09
DS(2,3)	0.46	1.00	0.00	0.00	8834.72	8869.67
DS(3,1)	0.46	1.00	0.01	0.01	8833.01	8856.30
DS(3,2)	0.47	1.00	0.00	0.00	8836.42	8877.19
DS(3,3)	0.47	1.00	0.00	0.00	8837.41	8884.00
ADL(1,1)	0.46	1.00	0.05	0.06	7097.86	7126.98
ADL(1,2)	0.46	1.00	0.04	0.05	7099.14	7134.08
ADL(1,3)	0.46	1.00	0.04	0.05	7099.76	7140.53
ADL(2,1)	0.46	1.00	0.00	0.00	7097.86	7126.98
ADL(2,2)	0.46	1.00	0.00	0.00	7100.11	7140.87
ADL(2,3)	0.46	1.00	0.00	0.00	7101.27	7147.86
ADL(3,1)	0.46	1.00	0.00	0.00	7100.09	7140.86
ADL(3,2)	0.46	1.00	0.00	0.00	7101.39	7147.98
ADL(3,3)	0.46	1.00	0.00	0.00	7101.86	7154.28

PA(1) $\rho_y = .9$, CS = 25, T = 100

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.65	1.00	1.00	1.00	50676.05	12670.26
PA(1)	0.08	1.00	0.04	0.03	7099.43	7122.73
PA(2)	0.08	1.00	0.01	0.01	7100.53	7129.65
PA(3)	0.07	1.00	0.01	0.01	7101.58	7136.52
FDL(1)	0.63	1.00	1.00	1.00	12430.52	12453.82
FDL(2)	0.64	1.00	1.00	1.00	12226.30	12255.42
FDL(3)	0.64	1.00	1.00	1.00	12045.20	12080.14
DS(1,1)	0.07	1.00	0.01	0.00	8834.34	8857.63
DS(1,2)	0.07	1.00	0.00	0.00	8835.47	8864.59
DS(1,3)	0.07	1.00	0.00	0.00	8836.10	8871.05
DS(2,1)	0.06	1.00	0.01	0.00	8834.34	8857.63
DS(2,2)	0.07	1.00	0.00	0.00	8835.47	8864.59
DS(2,3)	0.07	1.00	0.00	0.00	8836.10	8871.05
DS(3,1)	0.07	1.00	0.01	0.00	8834.34	8857.63
DS(3,2)	0.07	1.00	0.00	0.00	8837.19	8877.96
DS(3,3)	0.07	1.00	0.00	0.00	8838.07	8884.67
ADL(1,1)	0.08	1.00	0.05	0.03	7100.62	7129.74
ADL(1,2)	0.08	1.00	0.04	0.03	7101.22	7136.16
ADL(1,3)	0.08	1.00	0.04	0.03	7102.09	7142.86
ADL(2,1)	0.08	1.00	0.00	0.00	7100.62	7129.74
ADL(2,2)	0.08	1.00	0.00	0.00	7102.27	7143.04
ADL(2,3)	0.08	1.00	0.00	0.00	7103.50	7150.09
ADL(3,1)	0.08	1.00	0.00	0.00	7102.57	7143.34
ADL(3,2)	0.08	1.00	0.00	0.00	7103.49	7150.08
ADL(3,3)	0.07	1.00	0.00	0.00	7104.37	7156.79

PA(1) $\rho_y = .9$, CS = 100, T = 100

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.54	1.00	1.00	1.00	50676.05	50697.68
PA(1)	0.15	1.00	0.04	0.03	28379.80	28408.64
PA(2)	0.15	1.00	0.01	0.01	28380.98	28417.03
PA(3)	0.15	1.00	0.01	0.01	28381.89	28425.15
FDL(1)	0.54	1.00	1.00	1.00	49769.47	49798.31
FDL(2)	0.54	1.00	1.00	1.00	48958.13	48994.18
FDL(3)	0.55	1.00	1.00	1.00	48243.75	48287.01
DS(1,1)	0.18	1.00	0.01	0.00	35315.29	35344.13
DS(1,2)	0.17	1.00	0.00	0.00	35316.92	35352.97
DS(1,3)	0.17	1.00	0.00	0.00	35318.49	35361.75
DS(2,1)	0.17	1.00	0.01	0.00	35315.29	35344.13
DS(2,2)	0.18	1.00	0.00	0.00	35316.92	35352.97
DS(2,3)	0.17	1.00	0.00	0.00	35318.49	35361.75
DS(3,1)	0.17	1.00	0.01	0.00	35315.29	35344.13
DS(3,2)	0.17	1.00	0.00	0.00	35318.40	35368.87
DS(3,3)	0.17	1.00	0.00	0.00	35319.57	35377.26
ADL(1,1)	0.15	1.00	0.04	0.04	28380.50	28416.55
ADL(1,2)	0.15	1.00	0.04	0.04	28381.80	28425.06
ADL(1,3)	0.15	1.00	0.04	0.04	28382.54	28433.01
ADL(2,1)	0.15	1.00	0.00	0.00	28380.50	28416.55
ADL(2,2)	0.15	1.00	0.00	0.00	28383.66	28434.14
ADL(2,3)	0.15	1.00	0.00	0.00	28383.70	28441.38
ADL(3,1)	0.15	1.00	0.00	0.00	28383.15	28433.63
ADL(3,2)	0.15	1.00	0.00	0.00	28383.72	28441.40
ADL(3,3)	0.15	1.00	0.00	0.00	28384.68	28449.57

FDL(1) $\rho_x = .5$, CS = 25, T = 25

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.16	1.00	0.03	0.03	2209.53	2222.85
PA(1)	0.20	1.00	0.00	1.00	2018.19	2035.95
PA(2)	0.20	1.00	0.00	1.00	2015.59	2037.77
PA(3)	0.20	1.00	0.00	1.00	2016.29	2042.92
FDL(1)	0.15	0.07	0.05	0.07	1779.72	1797.47
FDL(2)	0.15	0.08	0.05	0.07	1780.22	1802.41
FDL(3)	0.15	0.07	0.05	0.06	1781.07	1807.69
DS(1,1)	0.12	1.00	0.01	0.02	2210.62	2228.37
DS(1,2)	0.12	1.00	0.00	0.00	2210.95	2233.14
DS(1,3)	0.12	1.00	0.00	0.00	2212.10	2238.73
DS(2,1)	0.13	1.00	0.00	0.00	2210.62	2228.37
DS(2,2)	0.13	1.00	0.00	0.00	2210.95	2233.14
DS(2,3)	0.13	1.00	0.00	0.00	2212.10	2238.73
DS(3,1)	0.12	1.00	0.00	0.00	2210.62	2228.37
DS(3,2)	0.13	1.00	0.00	0.00	2213.04	2244.10
DS(3,3)	0.13	1.00	0.00	0.00	2214.22	2249.72
ADL(1,1)	0.15	1.00	0.01	0.01	1780.46	1802.65
ADL(1,2)	0.15	1.00	0.00	0.00	1781.66	1808.28
ADL(1,3)	0.15	1.00	0.00	0.00	1782.10	1813.16
ADL(2,1)	0.15	1.00	0.00	0.00	1780.46	1802.65
ADL(2,2)	0.15	1.00	0.00	0.00	1781.93	1813.00
ADL(2,3)	0.15	1.00	0.00	0.00	1782.60	1818.10
ADL(3,1)	0.15	1.00	0.00	0.00	1782.05	1813.12
ADL(3,2)	0.15	1.00	0.00	0.00	1782.96	1818.46
ADL(3,3)	0.14	1.00	0.00	0.00	1783.95	1823.89

FDL(1) $\rho_x = .5$, CS = 100, T = 25

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.48	1.00	0.03	0.03	8824.04	8841.51
PA(1)	0.47	1.00	0.00	1.00	8055.50	8078.80
PA(2)	0.47	1.00	0.00	1.00	8041.45	8070.57
PA(3)	0.47	1.00	0.00	1.00	8042.19	8077.14
FDL(1)	0.46	0.05	0.04	0.06	7097.24	7120.54
FDL(2)	0.46	0.05	0.04	0.06	7098.10	7127.22
FDL(3)	0.46	0.05	0.04	0.06	7098.88	7133.83
DS(1,1)	0.46	1.00	0.02	0.02	8833.02	8856.32
DS(1,2)	0.46	1.00	0.01	0.00	8834.26	8863.38
DS(1,3)	0.46	1.00	0.01	0.00	8834.84	8869.78
DS(2,1)	0.46	1.00	0.00	0.00	8833.02	8856.32
DS(2,2)	0.46	1.00	0.00	0.00	8834.26	8863.38
DS(2,3)	0.46	1.00	0.00	0.00	8834.84	8869.78
DS(3,1)	0.46	1.00	0.00	0.00	8833.02	8856.32
DS(3,2)	0.46	1.00	0.00	0.00	8836.38	8877.15
DS(3,3)	0.47	1.00	0.00	0.00	8837.28	8883.87
ADL(1,1)	0.46	1.00	0.01	0.01	7098.34	7127.46
ADL(1,2)	0.46	1.00	0.00	0.00	7099.48	7134.42
ADL(1,3)	0.46	1.00	0.00	0.00	7100.25	7141.02
ADL(2,1)	0.46	1.00	0.01	0.00	7098.34	7127.46
ADL(2,2)	0.46	1.00	0.00	0.00	7100.09	7140.85
ADL(2,3)	0.46	1.00	0.00	0.00	7101.40	7147.99
ADL(3,1)	0.46	1.00	0.01	0.00	7100.50	7141.27
ADL(3,2)	0.46	1.00	0.00	0.00	7101.74	7148.33
ADL(3,3)	0.46	1.00	0.00	0.00	7101.95	7154.37

FDL(1) $\rho_x = .5$, CS = 25, T = 100

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.06	1.00	0.02	0.01	35316.40	8850.13
PA(1)	0.10	1.00	0.00	1.00	8064.86	8088.15
PA(2)	0.10	1.00	0.00	1.00	8048.64	8077.76
PA(3)	0.11	1.00	0.00	1.00	8049.24	8084.19
FDL(1)	0.08	0.08	0.04	0.04	7099.86	7123.16
FDL(2)	0.08	0.08	0.04	0.04	7100.98	7130.10
FDL(3)	0.08	0.08	0.04	0.04	7101.01	7135.95
DS(1,1)	0.07	1.00	0.02	0.01	8833.72	8857.02
DS(1,2)	0.07	1.00	0.01	0.00	8834.53	8863.65
DS(1,3)	0.07	1.00	0.01	0.00	8835.79	8870.74
DS(2,1)	0.07	1.00	0.00	0.00	8833.72	8857.02
DS(2,2)	0.06	1.00	0.00	0.00	8834.53	8863.65
DS(2,3)	0.07	1.00	0.00	0.00	8835.79	8870.74
DS(3,1)	0.07	1.00	0.00	0.00	8833.72	8857.02
DS(3,2)	0.06	1.00	0.00	0.00	8836.11	8876.88
DS(3,3)	0.07	1.00	0.00	0.00	8837.58	8884.17
ADL(1,1)	0.08	1.00	0.01	0.01	7101.51	7130.63
ADL(1,2)	0.08	1.00	0.00	0.00	7102.13	7137.08
ADL(1,3)	0.08	1.00	0.00	0.00	7102.27	7143.04
ADL(2,1)	0.08	1.00	0.00	0.00	7101.51	7130.63
ADL(2,2)	0.08	1.00	0.00	0.00	7102.55	7143.32
ADL(2,3)	0.08	1.00	0.00	0.00	7103.58	7150.17
ADL(3,1)	0.08	1.00	0.01	0.00	7102.49	7143.26
ADL(3,2)	0.08	1.00	0.00	0.00	7103.65	7150.24
ADL(3,3)	0.08	1.00	0.00	0.00	7105.02	7157.43

FDL(1) $\rho_x = .5$, CS = 100, T = 100

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.15	1.00	0.01	0.01	35316.40	35338.03
PA(1)	0.17	1.00	0.00	1.00	32235.44	32264.28
PA(2)	0.18	1.00	0.00	1.00	32166.83	32202.88
PA(3)	0.18	1.00	0.00	1.00	32166.50	32209.76
FDL(1)	0.15	0.05	0.04	0.04	28379.29	28408.14
FDL(2)	0.15	0.05	0.04	0.04	28380.18	28416.23
FDL(3)	0.15	0.05	0.04	0.04	28381.92	28425.18
DS(1,1)	0.17	1.00	0.02	0.01	35315.43	35344.27
DS(1,2)	0.17	1.00	0.00	0.00	35317.00	35353.05
DS(1,3)	0.17	1.00	0.00	0.00	35318.56	35361.82
DS(2,1)	0.17	1.00	0.00	0.00	35315.43	35344.27
DS(2,2)	0.17	1.00	0.00	0.00	35317.00	35353.05
DS(2,3)	0.17	1.00	0.00	0.00	35318.56	35361.82
DS(3,1)	0.17	1.00	0.00	0.00	35315.43	35344.27
DS(3,2)	0.17	1.00	0.00	0.00	35318.96	35369.44
DS(3,3)	0.17	1.00	0.00	0.00	35319.94	35377.62
ADL(1,1)	0.15	1.00	0.01	0.00	28380.28	28416.33
ADL(1,2)	0.15	1.00	0.00	0.00	28381.86	28425.12
ADL(1,3)	0.15	1.00	0.00	0.00	28383.61	28434.08
ADL(2,1)	0.15	1.00	0.01	0.00	28380.28	28416.33
ADL(2,2)	0.15	1.00	0.00	0.00	28382.64	28433.11
ADL(2,3)	0.15	1.00	0.00	0.00	28383.48	28441.16
ADL(3,1)	0.15	1.00	0.01	0.00	28383.22	28433.70
ADL(3,2)	0.15	1.00	0.00	0.00	28383.51	28441.19
ADL(3,3)	0.15	1.00	0.00	0.00	28384.99	28449.88

FDL(1) $\rho_x = .9$, CS = 25, T = 25

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.16	1.00	0.06	0.05	2202.96	2216.27
PA(1)	0.20	1.00	0.00	1.00	1968.31	1986.06
PA(2)	0.20	1.00	0.00	1.00	1969.16	1991.35
PA(3)	0.20	1.00	0.00	1.00	1970.27	1996.90
FDL(1)	0.16	0.07	0.05	0.06	1779.58	1797.33
FDL(2)	0.15	0.08	0.05	0.06	1780.89	1803.08
FDL(3)	0.15	0.07	0.05	0.06	1781.70	1808.32
DS(1,1)	0.12	1.00	0.05	0.06	2211.08	2228.83
DS(1,2)	0.12	1.00	0.01	0.01	2211.31	2233.49
DS(1,3)	0.13	1.00	0.01	0.01	2212.08	2238.70
DS(2,1)	0.13	1.00	0.00	0.00	2211.08	2228.83
DS(2,2)	0.13	1.00	0.00	0.00	2211.31	2233.49
DS(2,3)	0.13	1.00	0.00	0.00	2212.08	2238.70
DS(3,1)	0.12	1.00	0.00	0.00	2211.08	2228.83
DS(3,2)	0.13	1.00	0.00	0.00	2213.07	2244.13
DS(3,3)	0.13	1.00	0.00	0.00	2214.36	2249.86
ADL(1,1)	0.15	1.00	0.01	0.01	1780.99	1803.18
ADL(1,2)	0.15	1.00	0.00	0.00	1782.22	1808.84
ADL(1,3)	0.15	1.00	0.00	0.00	1783.12	1814.19
ADL(2,1)	0.15	1.00	0.00	0.00	1780.99	1803.18
ADL(2,2)	0.15	1.00	0.00	0.00	1782.58	1813.64
ADL(2,3)	0.15	1.00	0.00	0.00	1783.35	1818.85
ADL(3,1)	0.15	1.00	0.00	0.00	1782.73	1813.79
ADL(3,2)	0.15	1.00	0.00	0.00	1783.30	1818.81
ADL(3,3)	0.15	1.00	0.00	0.00	1784.33	1824.27

FDL(1) $\rho_x = .9$, CS = 100, T = 25

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.47	1.00	0.05	0.07	8797.12	8814.59
PA(1)	0.47	1.00	0.00	1.00	7856.75	7880.05
PA(2)	0.47	1.00	0.00	1.00	7858.17	7887.29
PA(3)	0.47	1.00	0.00	1.00	7859.35	7894.30
FDL(1)	0.46	0.05	0.04	0.06	7096.86	7120.15
FDL(2)	0.46	0.05	0.04	0.06	7097.95	7127.07
FDL(3)	0.46	0.05	0.04	0.06	7098.97	7133.91
DS(1,1)	0.46	1.00	0.05	0.05	8833.39	8856.69
DS(1,2)	0.46	1.00	0.01	0.01	8834.09	8863.21
DS(1,3)	0.46	1.00	0.01	0.01	8835.09	8870.04
DS(2,1)	0.46	1.00	0.00	0.00	8833.39	8856.69
DS(2,2)	0.46	1.00	0.00	0.00	8834.09	8863.21
DS(2,3)	0.46	1.00	0.00	0.00	8835.09	8870.04
DS(3,1)	0.46	1.00	0.00	0.00	8833.39	8856.69
DS(3,2)	0.46	1.00	0.00	0.00	8836.75	8877.52
DS(3,3)	0.47	1.00	0.00	0.00	8837.77	8884.36
ADL(1,1)	0.46	1.00	0.01	0.01	7098.23	7127.35
ADL(1,2)	0.46	1.00	0.00	0.00	7099.37	7134.31
ADL(1,3)	0.46	1.00	0.00	0.00	7100.25	7141.02
ADL(2,1)	0.46	1.00	0.00	0.00	7098.23	7127.35
ADL(2,2)	0.46	1.00	0.00	0.00	7099.98	7140.75
ADL(2,3)	0.46	1.00	0.00	0.00	7100.76	7147.35
ADL(3,1)	0.46	1.00	0.00	0.00	7100.61	7141.38
ADL(3,2)	0.46	1.00	0.00	0.00	7101.43	7148.03
ADL(3,3)	0.46	1.00	0.00	0.00	7102.11	7154.53

FDL(1) $\rho_x = .9$, CS = 25, T = 100

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.06	1.00	0.04	0.04	35285.83	8841.42
PA(1)	0.10	1.00	0.00	1.00	7863.03	7886.32
PA(2)	0.11	1.00	0.00	1.00	7864.04	7893.16
PA(3)	0.11	1.00	0.00	1.00	7865.08	7900.02
FDL(1)	0.08	0.08	0.04	0.04	7099.77	7123.07
FDL(2)	0.08	0.08	0.04	0.04	7100.72	7129.84
FDL(3)	0.08	0.08	0.04	0.04	7101.51	7136.46
DS(1,1)	0.06	1.00	0.04	0.04	8834.06	8857.36
DS(1,2)	0.07	1.00	0.01	0.01	8834.56	8863.68
DS(1,3)	0.06	1.00	0.01	0.01	8835.62	8870.56
DS(2,1)	0.06	1.00	0.00	0.00	8834.06	8857.36
DS(2,2)	0.07	1.00	0.00	0.00	8834.56	8863.68
DS(2,3)	0.06	1.00	0.00	0.00	8835.62	8870.56
DS(3,1)	0.06	1.00	0.00	0.00	8834.06	8857.36
DS(3,2)	0.06	1.00	0.00	0.00	8836.69	8877.46
DS(3,3)	0.07	1.00	0.00	0.00	8837.71	8884.31
ADL(1,1)	0.08	1.00	0.01	0.01	7100.81	7129.93
ADL(1,2)	0.08	1.00	0.00	0.00	7101.70	7136.65
ADL(1,3)	0.08	1.00	0.00	0.00	7102.27	7143.03
ADL(2,1)	0.08	1.00	0.00	0.00	7100.81	7129.93
ADL(2,2)	0.08	1.00	0.00	0.00	7102.28	7143.05
ADL(2,3)	0.08	1.00	0.00	0.00	7103.56	7150.15
ADL(3,1)	0.08	1.00	0.00	0.00	7102.41	7143.18
ADL(3,2)	0.08	1.00	0.00	0.00	7103.20	7149.80
ADL(3,3)	0.08	1.00	0.00	0.00	7104.66	7157.08

FDL(1) $\rho_x = .9$, CS = 100, T = 100

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.15	1.00	0.04	0.04	35285.83	35307.46
PA(1)	0.17	1.00	0.00	1.00	31423.91	31452.75
PA(2)	0.17	1.00	0.00	1.00	31422.94	31458.99
PA(3)	0.17	1.00	0.00	1.00	31424.10	31467.37
FDL(1)	0.15	0.05	0.04	0.04	28379.08	28407.92
FDL(2)	0.15	0.05	0.04	0.04	28380.29	28416.34
FDL(3)	0.15	0.05	0.04	0.04	28381.73	28424.99
DS(1,1)	0.18	1.00	0.05	0.05	35315.39	35344.24
DS(1,2)	0.17	1.00	0.01	0.00	35316.64	35352.69
DS(1,3)	0.17	1.00	0.01	0.01	35318.30	35361.57
DS(2,1)	0.17	1.00	0.00	0.00	35315.39	35344.24
DS(2,2)	0.17	1.00	0.00	0.00	35316.64	35352.69
DS(2,3)	0.17	1.00	0.00	0.00	35318.30	35361.57
DS(3,1)	0.17	1.00	0.00	0.00	35315.39	35344.24
DS(3,2)	0.17	1.00	0.00	0.00	35318.98	35369.45
DS(3,3)	0.17	1.00	0.00	0.00	35319.70	35377.39
ADL(1,1)	0.15	1.00	0.01	0.01	28380.25	28416.30
ADL(1,2)	0.15	1.00	0.00	0.00	28381.23	28424.49
ADL(1,3)	0.15	1.00	0.00	0.00	28382.51	28432.98
ADL(2,1)	0.15	1.00	0.00	0.00	28380.25	28416.30
ADL(2,2)	0.15	1.00	0.00	0.00	28381.56	28432.04
ADL(2,3)	0.15	1.00	0.00	0.00	28382.97	28440.65
ADL(3,1)	0.15	1.00	0.00	0.00	28382.11	28432.58
ADL(3,2)	0.15	1.00	0.00	0.00	28383.25	28440.94
ADL(3,3)	0.15	1.00	0.00	0.00	28384.60	28449.50

ADL(1,1) $\rho_y = .5$, $\rho_x = .5$, CS = 25, T = 25

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.19	1.00	1.00	1.00	2955.42	2968.74
PA(1)	0.19	1.00	0.00	1.00	2080.00	2097.75
PA(2)	0.20	1.00	0.00	1.00	2016.74	2038.93
PA(3)	0.20	1.00	0.00	1.00	2017.12	2043.75
FDL(1)	0.18	1.00	1.00	1.00	2383.66	2401.41
FDL(2)	0.18	1.00	1.00	1.00	2089.18	2111.37
FDL(3)	0.19	1.00	1.00	1.00	1991.59	2018.21
DS(1,1)	0.12	1.00	0.03	0.02	2211.01	2228.76
DS(1,2)	0.12	1.00	0.01	0.00	2211.45	2233.64
DS(1,3)	0.12	1.00	0.00	0.00	2211.85	2238.48
DS(2,1)	0.12	1.00	0.01	0.01	2211.01	2228.76
DS(2,2)	0.12	1.00	0.00	0.00	2211.45	2233.64
DS(2,3)	0.13	1.00	0.00	0.00	2211.85	2238.48
DS(3,1)	0.12	1.00	0.00	0.00	2211.01	2228.76
DS(3,2)	0.12	1.00	0.00	0.00	2213.12	2244.18
DS(3,3)	0.13	1.00	0.00	0.00	2214.41	2249.91
ADL(1,1)	0.15	1.00	0.03	0.04	1780.42	1802.61
ADL(1,2)	0.15	1.00	0.02	0.03	1781.03	1807.66
ADL(1,3)	0.15	1.00	0.01	0.01	1782.24	1813.31
ADL(2,1)	0.15	1.00	0.00	0.00	1780.42	1802.61
ADL(2,2)	0.15	1.00	0.00	0.00	1782.56	1813.62
ADL(2,3)	0.15	1.00	0.00	0.00	1782.87	1818.37
ADL(3,1)	0.15	1.00	0.00	0.00	1782.32	1813.38
ADL(3,2)	0.14	1.00	0.00	0.00	1783.13	1818.63
ADL(3,3)	0.15	1.00	0.00	0.00	1783.72	1823.66

ADL(1,1) $\rho_y = .5$, $\rho_x = .5$, CS = 100, T = 25

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.46	1.00	1.00	1.00	11816.75	11834.22
PA(1)	0.47	1.00	0.00	1.00	8305.60	8328.89
PA(2)	0.48	1.00	0.00	1.00	8046.65	8075.77
PA(3)	0.47	1.00	0.00	1.00	8042.10	8077.04
FDL(1)	0.45	1.00	1.00	1.00	9515.27	9538.56
FDL(2)	0.46	1.00	1.00	1.00	8351.24	8380.36
FDL(3)	0.46	1.00	1.00	1.00	7953.17	7988.12
DS(1,1)	0.46	1.00	0.03	0.03	8832.91	8856.20
DS(1,2)	0.46	1.00	0.01	0.00	8833.91	8863.03
DS(1,3)	0.46	1.00	0.01	0.00	8834.54	8869.48
DS(2,1)	0.46	1.00	0.01	0.00	8832.91	8856.20
DS(2,2)	0.47	1.00	0.00	0.00	8833.91	8863.03
DS(2,3)	0.47	1.00	0.00	0.00	8834.54	8869.48
DS(3,1)	0.47	1.00	0.00	0.00	8832.91	8856.20
DS(3,2)	0.47	1.00	0.00	0.00	8835.85	8876.62
DS(3,3)	0.47	1.00	0.00	0.00	8837.21	8883.80
ADL(1,1)	0.46	1.00	0.04	0.04	7098.07	7127.19
ADL(1,2)	0.46	1.00	0.02	0.02	7099.02	7133.96
ADL(1,3)	0.46	1.00	0.00	0.01	7099.87	7140.64
ADL(2,1)	0.46	1.00	0.01	0.00	7098.07	7127.19
ADL(2,2)	0.46	1.00	0.00	0.00	7100.39	7141.16
ADL(2,3)	0.46	1.00	0.00	0.00	7101.12	7147.71
ADL(3,1)	0.46	1.00	0.01	0.00	7100.10	7140.86
ADL(3,2)	0.46	1.00	0.00	0.00	7101.16	7147.75
ADL(3,3)	0.46	1.00	0.00	0.00	7102.04	7154.46

ADL(1,1) $\rho_y = .5$, $\rho_x = .5$, CS = 25, T = 100

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.14	1.00	1.00	1.00	47338.05	11851.05
PA(1)	0.07	1.00	0.00	1.00	8316.15	8339.45
PA(2)	0.11	1.00	0.00	1.00	8055.35	8084.47
PA(3)	0.11	1.00	0.00	1.00	8049.87	8084.81
FDL(1)	0.14	1.00	1.00	1.00	9543.97	9567.26
FDL(2)	0.15	1.00	1.00	1.00	8374.61	8403.73
FDL(3)	0.15	1.00	1.00	1.00	7972.09	8007.03
DS(1,1)	0.07	1.00	0.03	0.02	8833.77	8857.07
DS(1,2)	0.07	1.00	0.01	0.00	8835.11	8864.23
DS(1,3)	0.07	1.00	0.01	0.00	8835.77	8870.72
DS(2,1)	0.07	1.00	0.00	0.00	8833.77	8857.07
DS(2,2)	0.07	1.00	0.00	0.00	8835.11	8864.23
DS(2,3)	0.07	1.00	0.00	0.00	8835.77	8870.72
DS(3,1)	0.07	1.00	0.00	0.00	8833.77	8857.07
DS(3,2)	0.07	1.00	0.00	0.00	8836.15	8876.92
DS(3,3)	0.06	1.00	0.00	0.00	8837.40	8883.99
ADL(1,1)	0.08	1.00	0.04	0.03	7101.26	7130.38
ADL(1,2)	0.08	1.00	0.01	0.01	7101.16	7136.10
ADL(1,3)	0.08	1.00	0.01	0.00	7102.13	7142.90
ADL(2,1)	0.08	1.00	0.01	0.00	7101.26	7130.38
ADL(2,2)	0.08	1.00	0.00	0.00	7102.32	7143.08
ADL(2,3)	0.08	1.00	0.00	0.00	7103.30	7149.89
ADL(3,1)	0.08	1.00	0.01	0.00	7102.54	7143.31
ADL(3,2)	0.08	1.00	0.00	0.00	7103.47	7150.06
ADL(3,3)	0.08	1.00	0.00	0.00	7104.33	7156.75

ADL(1,1) $\rho_y = .5$, $\rho_x = .5$, CS = 100, T = 100

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.23	1.00	1.00	1.00	47338.05	47359.69
PA(1)	0.16	1.00	0.00	1.00	33230.57	33259.41
PA(2)	0.18	1.00	0.00	1.00	32191.89	32227.94
PA(3)	0.18	1.00	0.00	1.00	32167.31	32210.58
FDL(1)	0.23	1.00	1.00	1.00	38166.11	38194.95
FDL(2)	0.24	1.00	1.00	1.00	33477.75	33513.80
FDL(3)	0.24	1.00	1.00	1.00	31861.11	31904.37
DS(1,1)	0.18	1.00	0.02	0.01	35316.16	35345.00
DS(1,2)	0.17	1.00	0.01	0.00	35317.07	35353.12
DS(1,3)	0.17	1.00	0.00	0.00	35318.51	35361.77
DS(2,1)	0.17	1.00	0.00	0.00	35316.16	35345.00
DS(2,2)	0.17	1.00	0.00	0.00	35317.07	35353.12
DS(2,3)	0.17	1.00	0.00	0.00	35318.51	35361.77
DS(3,1)	0.17	1.00	0.00	0.00	35316.16	35345.00
DS(3,2)	0.17	1.00	0.00	0.00	35319.31	35369.78
DS(3,3)	0.17	1.00	0.00	0.00	35320.06	35377.75
ADL(1,1)	0.15	1.00	0.04	0.03	28380.49	28416.54
ADL(1,2)	0.15	1.00	0.02	0.01	28381.36	28424.62
ADL(1,3)	0.15	1.00	0.00	0.00	28382.79	28433.27
ADL(2,1)	0.15	1.00	0.01	0.00	28380.49	28416.54
ADL(2,2)	0.15	1.00	0.00	0.00	28382.84	28433.31
ADL(2,3)	0.15	1.00	0.00	0.00	28384.33	28442.02
ADL(3,1)	0.15	1.00	0.01	0.00	28383.25	28433.72
ADL(3,2)	0.15	1.00	0.00	0.00	28383.84	28441.52
ADL(3,3)	0.15	1.00	0.00	0.00	28384.95	28449.84

ADL(1,1) $\rho_y = .9$, $\rho_x = .9$, CS = 25, T = 25

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.49	1.00	1.00	1.00	5299.89	5313.20
PA(1)	0.17	1.00	0.01	0.04	2142.78	2160.53
PA(2)	0.20	1.00	0.00	1.00	1970.06	1992.25
PA(3)	0.20	1.00	0.00	1.00	1970.89	1997.52
FDL(1)	0.50	1.00	1.00	1.00	5136.02	5153.77
FDL(2)	0.51	1.00	1.00	1.00	4968.09	4990.28
FDL(3)	0.50	1.00	1.00	1.00	4797.67	4824.30
DS(1,1)	0.12	1.00	0.04	0.03	2211.28	2229.04
DS(1,2)	0.12	1.00	0.04	0.03	2211.71	2233.90
DS(1,3)	0.12	1.00	0.01	0.00	2212.24	2238.87
DS(2,1)	0.12	1.00	0.02	0.01	2211.28	2229.04
DS(2,2)	0.12	1.00	0.00	0.00	2211.71	2233.90
DS(2,3)	0.13	1.00	0.00	0.00	2212.24	2238.87
DS(3,1)	0.12	1.00	0.02	0.01	2211.28	2229.04
DS(3,2)	0.12	1.00	0.00	0.00	2213.31	2244.38
DS(3,3)	0.13	1.00	0.00	0.00	2214.74	2250.25
ADL(1,1)	0.15	0.70	0.05	0.07	1780.59	1802.78
ADL(1,2)	0.16	0.87	0.05	0.06	1781.17	1807.80
ADL(1,3)	0.16	0.95	0.06	0.07	1782.39	1813.46
ADL(2,1)	0.15	1.00	0.00	0.00	1780.59	1802.78
ADL(2,2)	0.15	1.00	0.00	0.00	1782.73	1813.80
ADL(2,3)	0.15	1.00	0.00	0.00	1783.53	1819.04
ADL(3,1)	0.15	1.00	0.00	0.00	1782.48	1813.54
ADL(3,2)	0.15	1.00	0.00	0.00	1783.50	1819.01
ADL(3,3)	0.15	1.00	0.00	0.00	1784.19	1824.13

ADL(1,1) $\rho_y = .9$, $\rho_x = .9$, CS = 100, T = 25

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.58	1.00	1.00	1.00	21249.15	21266.63
PA(1)	0.47	1.00	0.00	0.06	8553.81	8577.10
PA(2)	0.47	1.00	0.00	1.00	7858.24	7887.36
PA(3)	0.47	1.00	0.00	1.00	7859.34	7894.28
FDL(1)	0.59	1.00	1.00	1.00	20592.88	20616.18
FDL(2)	0.59	1.00	1.00	1.00	19924.24	19953.36
FDL(3)	0.60	1.00	1.00	1.00	19244.41	19279.36
DS(1,1)	0.46	1.00	0.04	0.04	8833.24	8856.54
DS(1,2)	0.46	1.00	0.04	0.04	8834.10	8863.22
DS(1,3)	0.46	1.00	0.01	0.00	8835.26	8870.20
DS(2,1)	0.46	1.00	0.02	0.01	8833.24	8856.54
DS(2,2)	0.46	1.00	0.00	0.00	8834.10	8863.22
DS(2,3)	0.46	1.00	0.00	0.00	8835.26	8870.20
DS(3,1)	0.46	1.00	0.01	0.01	8833.24	8856.54
DS(3,2)	0.46	1.00	0.00	0.00	8836.48	8877.25
DS(3,3)	0.46	1.00	0.00	0.00	8837.13	8883.72
ADL(1,1)	0.46	1.00	0.05	0.06	7098.24	7127.36
ADL(1,2)	0.46	1.00	0.05	0.06	7099.27	7134.21
ADL(1,3)	0.46	1.00	0.05	0.06	7100.07	7140.83
ADL(2,1)	0.46	1.00	0.01	0.01	7098.24	7127.36
ADL(2,2)	0.47	1.00	0.00	0.00	7100.43	7141.20
ADL(2,3)	0.46	1.00	0.00	0.00	7101.39	7147.98
ADL(3,1)	0.46	1.00	0.00	0.00	7100.75	7141.52
ADL(3,2)	0.46	1.00	0.00	0.00	7101.06	7147.66
ADL(3,3)	0.46	1.00	0.00	0.00	7101.91	7154.33

ADL(1,1) $\rho_y = .9$, $\rho_x = .9$, CS = 25, T = 100

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.60	1.00	1.00	1.00	89881.09	22475.85
PA(1)	0.06	1.00	0.00	0.09	8613.75	8637.05
PA(2)	0.10	1.00	0.00	1.00	7864.62	7893.74
PA(3)	0.10	1.00	0.00	1.00	7865.53	7900.48
FDL(1)	0.59	1.00	1.00	1.00	21915.43	21938.72
FDL(2)	0.59	1.00	1.00	1.00	21373.74	21402.86
FDL(3)	0.59	1.00	1.00	1.00	20828.29	20863.23
DS(1,1)	0.06	1.00	0.04	0.04	8833.30	8856.59
DS(1,2)	0.06	1.00	0.03	0.03	8834.67	8863.79
DS(1,3)	0.06	1.00	0.01	0.01	8835.85	8870.79
DS(2,1)	0.06	1.00	0.01	0.01	8833.30	8856.59
DS(2,2)	0.07	1.00	0.00	0.00	8834.67	8863.79
DS(2,3)	0.06	1.00	0.00	0.00	8835.85	8870.79
DS(3,1)	0.07	1.00	0.01	0.01	8833.30	8856.59
DS(3,2)	0.07	1.00	0.00	0.00	8837.21	8877.97
DS(3,3)	0.07	1.00	0.00	0.00	8837.55	8884.14
ADL(1,1)	0.08	0.99	0.05	0.04	7100.20	7129.32
ADL(1,2)	0.08	1.00	0.05	0.04	7101.31	7136.26
ADL(1,3)	0.08	1.00	0.05	0.04	7102.35	7143.12
ADL(2,1)	0.08	1.00	0.01	0.01	7100.20	7129.32
ADL(2,2)	0.08	1.00	0.00	0.00	7102.10	7142.87
ADL(2,3)	0.08	1.00	0.00	0.00	7103.25	7149.84
ADL(3,1)	0.08	1.00	0.00	0.00	7103.13	7143.90
ADL(3,2)	0.08	1.00	0.00	0.00	7103.28	7149.87
ADL(3,3)	0.08	1.00	0.00	0.00	7104.36	7156.78

ADL(1,1) $\rho_y = .9$, $\rho_x = .9$, CS = 100, T = 100

Model	Okui	Wooldridge	Bhargava	Bera	AIC	BIC
Static	0.55	1.00	1.00	1.00	89881.09	89902.72
PA(1)	0.16	1.00	0.00	0.27	34438.10	34466.94
PA(2)	0.17	1.00	0.00	1.00	31425.08	31461.13
PA(3)	0.17	1.00	0.00	1.00	31424.34	31467.60
FDL(1)	0.55	1.00	1.00	1.00	87707.00	87735.85
FDL(2)	0.55	1.00	1.00	1.00	85541.45	85577.50
FDL(3)	0.55	1.00	1.00	1.00	83375.65	83418.91
DS(1,1)	0.18	1.00	0.04	0.03	35315.14	35343.98
DS(1,2)	0.18	1.00	0.04	0.04	35316.47	35352.52
DS(1,3)	0.17	1.00	0.01	0.00	35318.31	35361.58
DS(2,1)	0.17	1.00	0.01	0.00	35315.14	35343.98
DS(2,2)	0.17	1.00	0.00	0.00	35316.47	35352.52
DS(2,3)	0.17	1.00	0.00	0.00	35318.31	35361.58
DS(3,1)	0.18	1.00	0.01	0.00	35315.14	35343.98
DS(3,2)	0.17	1.00	0.00	0.00	35319.19	35369.66
DS(3,3)	0.17	1.00	0.00	0.00	35320.03	35377.71
ADL(1,1)	0.15	1.00	0.05	0.04	28379.91	28415.97
ADL(1,2)	0.15	1.00	0.05	0.04	28380.32	28423.59
ADL(1,3)	0.15	1.00	0.05	0.04	28381.35	28431.82
ADL(2,1)	0.15	1.00	0.01	0.01	28379.91	28415.97
ADL(2,2)	0.15	1.00	0.00	0.00	28381.28	28431.75
ADL(2,3)	0.15	1.00	0.00	0.00	28382.78	28440.46
ADL(3,1)	0.15	1.00	0.00	0.00	28382.01	28432.48
ADL(3,2)	0.15	1.00	0.00	0.00	28382.93	28440.61
ADL(3,3)	0.15	1.00	0.00	0.00	28384.16	28449.05