Alternative Models of Dynamics in Binary Time-Series–Cross-Section Models: The Example of State Failure

Nathaniel Beck* David Epstein†

Simon Jackman‡ Sharyn O'Halloran§

Prepared for delivery at the
2001 Annual Meeting of the Society for Political Methodology,
Emory University.
Draft of July 16, 2001

*Department of Political Science; University of California, San Diego; La Jolla, CA 92093; beck@ucsd.edu

†Department of Political Science; Columbia University; NY, NY 10027; de11@columbia.edu

‡Department of Political Science; Stanford University; Stanford, CA 94305; jackman@stanford.edu

§Department of Political Science; Columbia University; NY, NY, 10027; so33@columbia.edu

Easy to Estimate Models

(Leave hard ones for Simon)

- Ordinary Probit - probably bad
- Statistical fixes and close
  - Huber standard errors (cluster on unit)
  - GEE (AR1 errors?)
- - Intercept shifts
  - Fixed effects - DOESN'T WORK FOR BTSCS (usually? often?)
  - Random effects - Doesn't do much
- Transition Related Models
  - Transition Model (Observation Driven!)
  - Lagged Dependent Variable - Restricted Transition Model
  - BKT
  - Transitions from 0 to 1 and 1 to 0
- Models with latent variables - Simon

Some models

Ordinary Probit

$$y_t^* = \mathbf{x}_t\beta + \epsilon_t \quad (1)$$

$$y_t = 1 \text{ if } y_t^* > 0 \quad (2)$$

$$y_t = 0 \text{ otherwise} \quad (3)$$

$$\epsilon_t \sim N(0,1) \quad (4)$$

Lagged Dependent Variable (Restricted Transition)

$$y_t^* = \mathbf{x}_t\beta + \rho y_{t-1} + \epsilon_t \quad (5)$$

Lagged Latent (Simon)

$$y_t^* = \mathbf{x}_t\beta + \rho y_{t-1}^* + \epsilon_t \quad (6)$$

Transition Model

$$P(y_t = 1 | y_{t-1} = 0) = \text{Probit}(\mathbf{x}_t \beta) \tag{7}$$

$$P(y_t = 1 | y_{t-1} = 1) = \text{Probit}(\mathbf{x}_t \alpha) \tag{8}$$

which can be writen more compactly as

$$P(y_t = 1) = \text{Probit}(\mathbf{x}_t \beta + y_{t-1} \mathbf{x}_t \gamma) \tag{9}$$

where

$$\gamma = \alpha - \beta. \tag{10}$$

Transition vs BKT

The transition model can be estimated as to separate probits (breaking data into subset with $y_{t-1} = 0$ and $y_{t-1} = 1$.

Unlike in the continuous DV case, the full interaction model and estimating on two subsets are identical for binary dependent variables.

This is because for each submodel, we must assume that the variance of the latent error is one.

Thus if we believe the transition model, we can equally estimate two separate models: one for onset, one for the maintenance of 1's.

Note in duration terminology, we have a discrete model for the lengths of spells of 0's and a separate model for the lengths of spells of 1's.

But because there are no time vars in the two models, the transition model assumes these spells are duration independent.

BKT focused on the transition from 0 to 1 (that is, lengths of spells of 0's) because that was what was interesting in the democratic peace.

But can easily allow for duration dependence in either or both spell lengths. Especially easy if model the two spells independently.

Thus there is no essential difference between the transition approach and BKT, except that BKT, in allowing for duration dependence, is more general.

Can test the null that the two processes are identical by testing whether all the interaction terms (and lagged y) have zero coefficient.

Can have different IVs for two processes.

Thinking about the data as event history does the usual good things for us in addition to duration dependence: second spell lengths might not be independent of previous spells. Can also use multiple destinations notions to deal with some forms of multinomial logit (but only if have longs strings of zeros followed by some type of "exit."

Ordinary probit and non-specification fixes

Table 1: Ordinary Probit Estimates of State Failure Model; All Failures

	Ordinary Probit			GEE	
Variable	$\hat{\beta}$	SE	Robust SE	$\hat{\beta}$	SE
OPEN	$-.71$	$.08$	$.23$	$-.31$	$.12$
DEMOC	$-.40$	$.07$	$.26$	$-.36$	$.09$
INFMORT	$.25$	$.04$	$.13$	$.28$	$.09$
POPDENS	$.19$	$.02$	$.07$	$.19$	$.05$
Constant	-2.12	$.21$	$.68$	-2.45	$.50$
$\hat{\rho}$				$.86$	
N=4596					

Transition Model

Table 2: Transition Model; All Failures; Duration Independent

	$y_{t-1} = 0$		$y_{t-1} = 0$	
Variable	$\hat{\beta}$	SE	$\hat{\beta}$	SE
OPEN	$-.39$	$.16$	$-.45$	$.22$
DEMOC	$-.55$	$.17$	$.55$	$.23$
INFMORT	$.17$	$.08$	$.10$	$.12$
POPDENS	$.08$	$.04$	$.07$	$.06$
Constant	-2.12	$.21$	$.75$	$.67$
	N=3632		N=817	

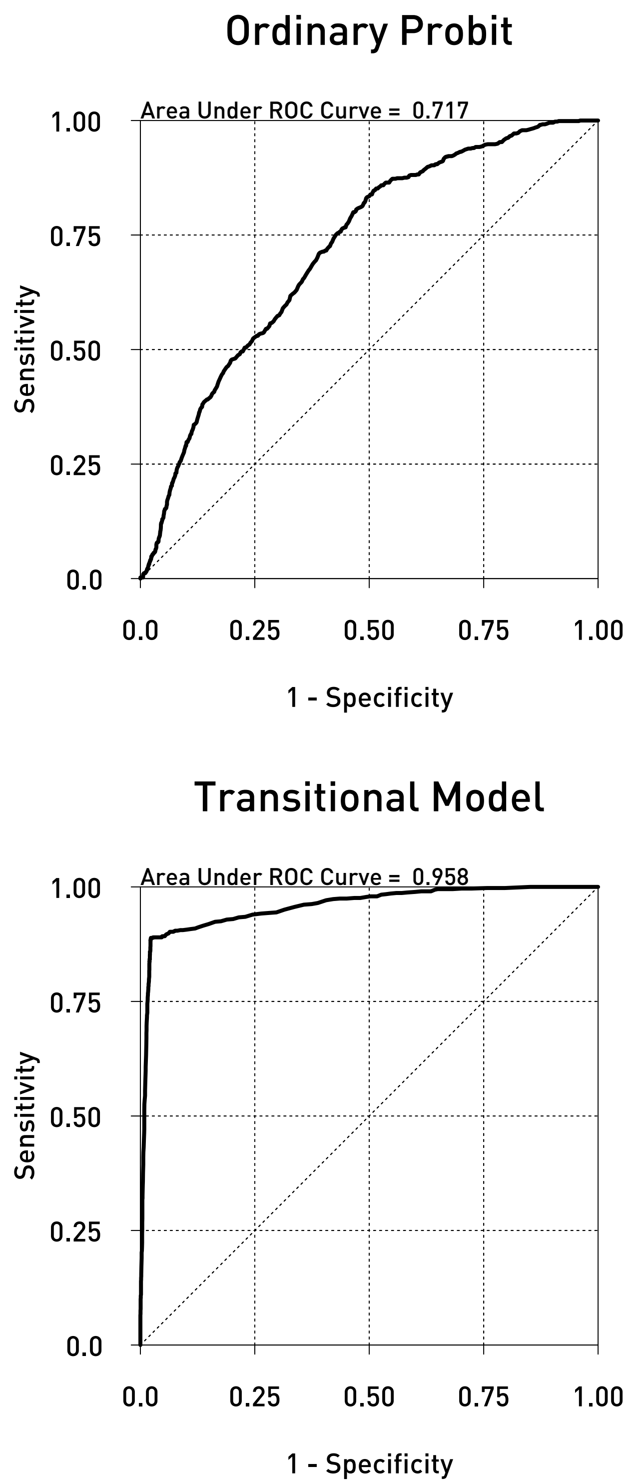

Figure 1: ROC Curves for Ordinary Probit and Transition Models

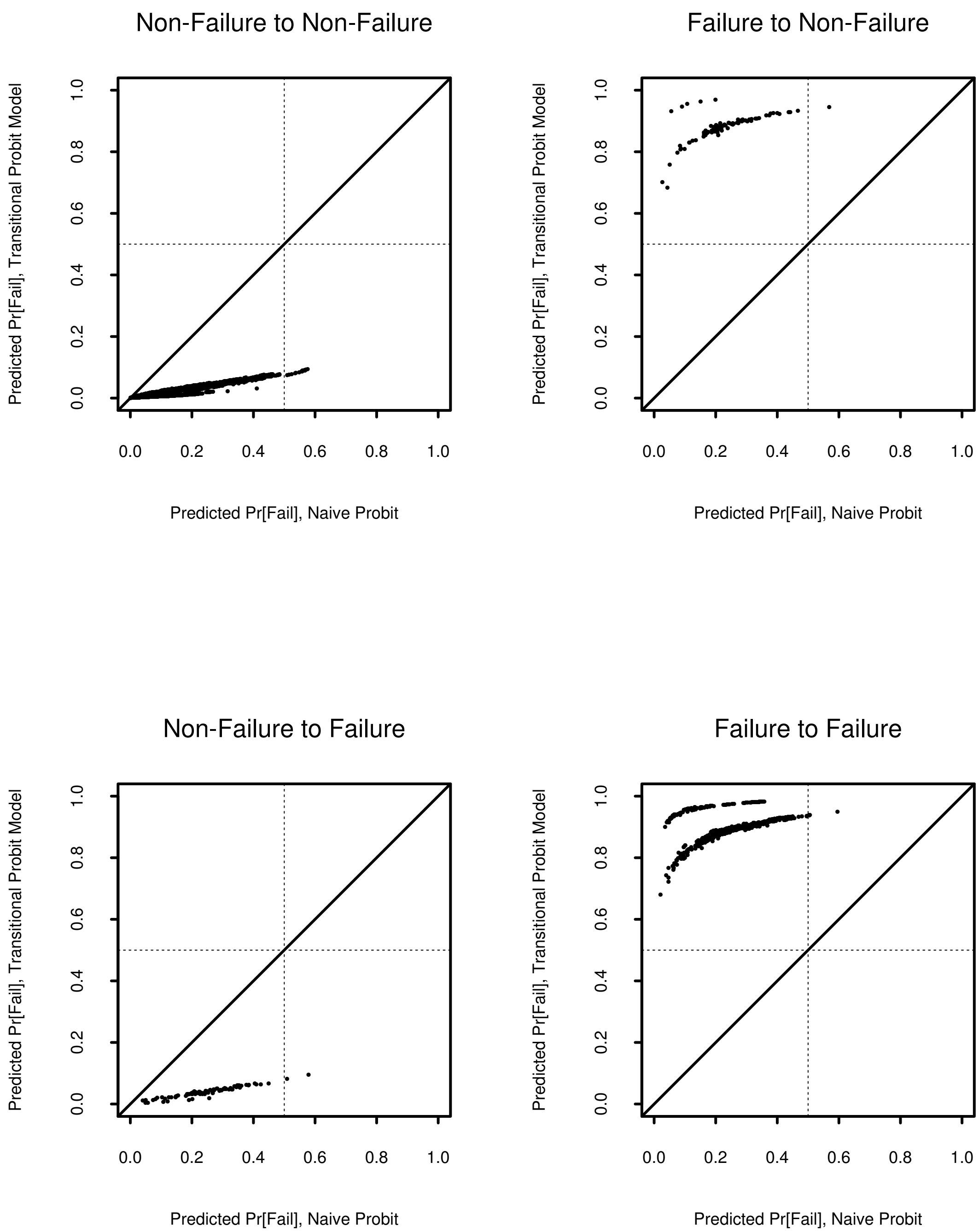

Figure 2: Comparison of Model Performance: Ordinary Probit vs. Transition

In sample performance

Table 3: In-Sample Prediction Summary

Model	$0 \rightarrow 0$	$0 \rightarrow 1$	$1 \rightarrow 0$	$1 \rightarrow 1$
Ordinary Probit	0.17	0.25	0.23	0.25
Full Transition	0.03	0.04	0.88	0.90
Restricted Transition	0.03	0.04	0.89	0.90
Lagged Latent	0.07	0.10	0.65	0.70

BKT on spells of failure

Table 4: Transition Model; Spells of Failure; Duration Dependence

Variable	$\hat{\beta}$	SE
OPEN	$-.35$	$.22$
DEMOC	$.38$	$.24$
INFMORT	$.12$	$.12$
POPDENS	$.07$	$.06$
FAILURE YEARS	$.03$	$.01$
Constant	$.41$	$.68$
	N=817	