Title: **AJAE Appendix for "Estimating Policy Effects on Spatial Market Efficiency: An Extension to the Parity Bounds Model"**

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Note: The material contained herein is supplementary to the article named in the title and published in the American Journal of Agricultural Economics (*AJAE*).

It is often argued that the reliability of PBM estimates depends critically on the validity of assumptions made about the underlying probability distributions. Barrett and Li (2002) have investigated this issue using Monte Carlo simulation and found that if the data generating process for rents to arbitrage deviates significantly from normality, but a normality assumption is maintained during estimation, then the PBM is likely to provide biased estimates of spatial disequilibrium and inefficiency. Here we follow a similar approach to investigate sensitivity of results to non-normality in the EPBM developed in Myers and Negassa (Forthcoming).

To obtain a baseline, we first used Monte Carlo simulations to randomly generate multiple sets of observations on spatial profit margins under the assumptions of normally distributed e_t and half-normal u_t and v_t. Sample size for each random draw was 100 and the first 50 observations were generated from a model with regime probabilities of $\lambda_1 = 0.5$, $\lambda_2 = 0.25$, and $\lambda_3 = 0.25$. The remaining 50 observations were then drawn assuming a 12 observation adjustment period to regime probabilities that changed by $\delta_1 = -0.25$, $\delta_2 = -0.15$, and $\delta_3 = 0.4$. After generating the 100 observations in this way the EPBM estimator was then applied to the data set, making the standard normality assumptions, and the estimation results tabulated. This whole process was then repeated 1000 times and the sample means of the 1000 parameter estimates were recorded.

Results for the baseline are reported as case (i) in the first column of table 1. As expected, the regime probability estimates of λ_k and δ_k for $k = 1,2,3$ are unbiased when the normality assumptions are correct. A surprising result is that the search procedure used to estimate the length of the adjustment period to policy change provides a downward biased estimate, even when the assumption of normal and half-normal distributions is correct (see table 1). We have not been able to find any theoretical results that either support or contradict this property of the grid search estimator used to estimate the length of the adjustment period. However, it should be noted that this is not a traditional maximum likelihood estimator and the simulation is based on small sample results. Therefore, it is quite possible that biased estimation of the adjustment length is a persistent feature of these types of models in small samples.

Next we investigated estimator performance under deviations from normality. Following Barrett and Li (2002), let equilibrium errors e_t follow a flexible exponential generalized beta distribution of the second type (EGB2), which allows for both leptokurtic and skewed distributions. The probability density function for EGB2 is provided in Barrett and Li (2002). Three types of parameterizations are investigated, one that has high leptokurtosis but maintains symmetry [case (ii) of table 1], one that has standard kurtosis but is highly positively skewed [case (iii)], and one that has mild leptokurtosis and mild positive skewness combined [case (iv)]. Results for each case are reported in table 1. Leptokurtosis has little effect on estimation of pre-policy change regime probabilities but introduces downward bias in estimates of the increase in the probability of being in regime 3 (i.e., movement towards inefficiency is under-estimated). Skewness introduces downward bias in estimates of the initial λ_3 and also downward bias in estimates of the size of an increase in the probability of being in regime 3 (i.e., initial level of inefficiency is under-estimated but movement towards more inefficiency is also under-estimated). Not surprisingly, skewness and leptokurtosis combined also introduce downward bias in the estimated increase in regime 3 probability (movement toward inefficiency is again underestimated).

Finally, and again following Barrett and Li (2002), we investigated cases where the u_t [case (v) of table 1] and v_t [case (vi) of table 1] are alternatively Chi-square with three degrees of freedom rather than half normal. While some biases are introduced in this case, the biases are much less severe than under skewed equilibrium errors (see table 1).

Overall, the results suggest that we do need to be concerned about sensitivity to alternative distributional assumptions when interpreting results from the EPBM, especially when there is positive skewness in equilibrium errors (in which case the extent of a shift towards a more spatially inefficient regime may be under-estimated). It is also interesting to note that the length of the adjustment period, which is downward biased when the normal distributional assumptions are correct, is actually estimated with less bias when the underlying data generating mechanism is not normally distributed (see the last row of table 1).

References

Barrett, C.B., and J.R. Li. 2002. "Distinguishing Between Equilibrium and Integration in Spatial Price Analysis." *American Journal of Agricultural Economics* 84:292-307.

Negassa, A., and R.J. Myers. Forthcoming. "Estimating Policy Effects on Spatial Market Efficiency: An Extension of the Parity Bounds Model." *American Journal of Agricultural Economics*, in press.

Table 1. Mean Parameter Estimates from Monte Carlo Simulations

Parameter	Normally distributed e_t Case (i)	High lepto-kurtosis in e_t Case (ii)	High positive skewness in e_t Case (iii)	Mild skewness and leptokurtosis in e_t Case (iv)	$u_t \sim \chi^2(3)$ Case (v)	$v_t \sim \chi^2(3)$ Case (vi)
λ_1	0.470	0.550	0.694	0.606	0.543	0.463
λ_2	0.260	0.222	0.200	0.123	0.233	0.385
λ_3	0.270	0.228	0.106	0.271	0.224	0.152
δ_1	-0.287	-0.337	-0.454	-0.346	-0.367	-0.270
δ_2	-0.125	0.117	0.249	0.119	-0.122	-0.080
δ_3	0.412	0.220	0.205	0.227	0.489	0.350
l	5.377	13.467	13.448	15.267	8..913	7.059

Notes: Results are based on 1000 replications of 100 observations each. Parameter values for the data generating process are λ_1 =0.50, λ_2=0.25, λ_3=0.25, δ_1=-0.25, δ_2=-0.15, δ_3= 0.40, and l=*12* periods in all cases.