Selected Poster prepared for presentation at the Agricultural & Applied Economics Association's 2014 AAEA Annual Meeting, Minneapolis, MN, July 27-29, 2014

EFFICIENCY GAINS IN COTTON PRICE FORECASTING USING DIFFERENT LEVELS OF DATA AGGREGATION

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INTRODUCTION

The forecasting efficiency gains obtained by building time series models in which the data are optimally aggregated have been studied from a theoretical perspective in numerous studies. However, an empirical study focused on the potential benefits of temporal disaggregation in commodity price forecasting has not been conducted.

This is the case even though commodities markets are extremely important for the economic performance of the U.S. agricultural sector, where a slight difference in a prediction represents losses of million of dollars. One important commodity is cotton, which generated approximately $25.0 billion in annual revenue and was responsible for 200,000 jobs in 2008 (USDA, 2012).

OBJECTIVE

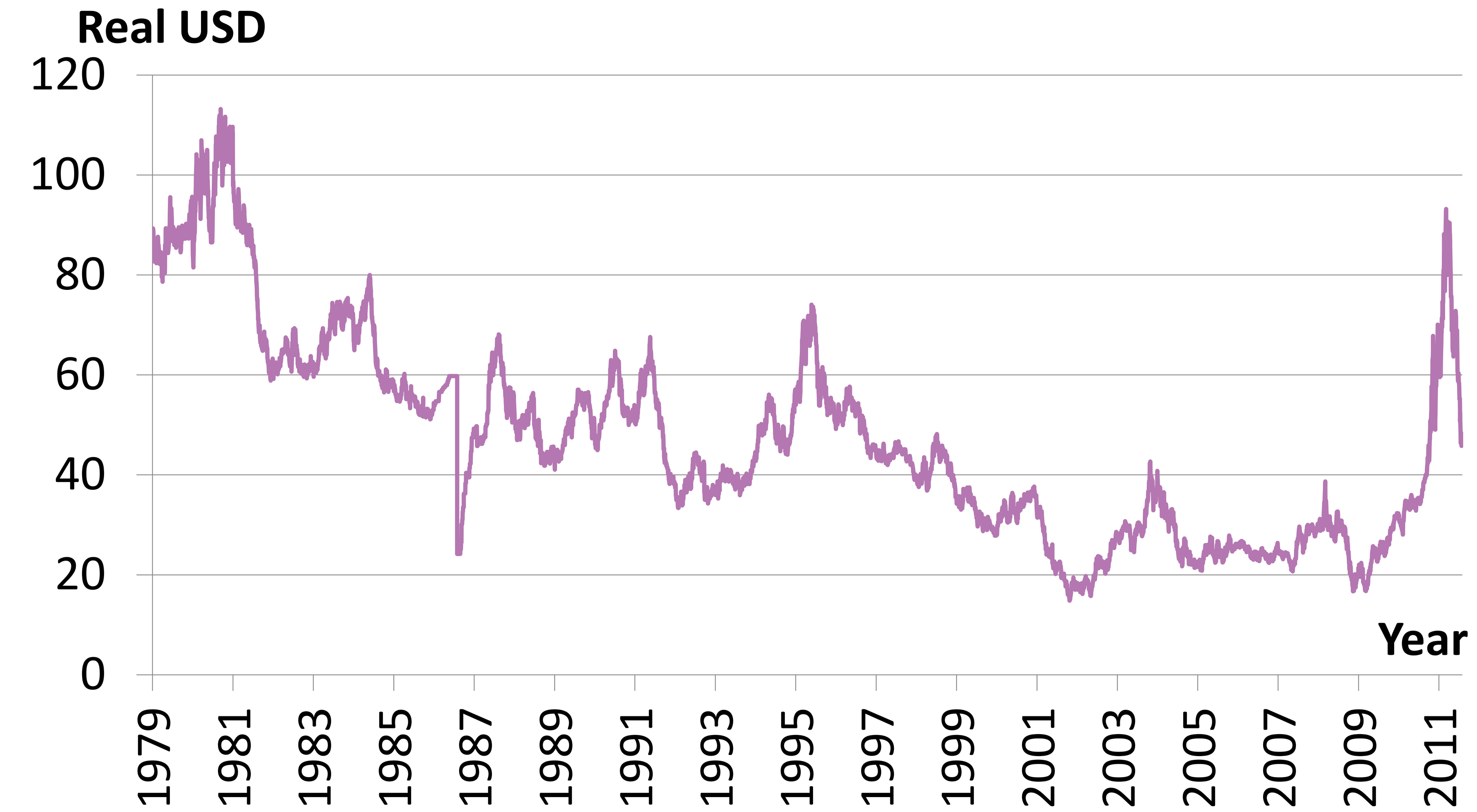
This study evaluates the efficiency gains in forecasting cotton cash prices using alternative ARMA models with varying levels of temporal aggregations (daily, weekly, monthly and annual).

More specifically, it evaluates whether the disaggregated models can produce more accurate aggregated price predictions than the corresponding aggregated models. Likewise, this is the first study that incorporates the daily level of aggregation to evaluate the efficiency gain in forecasting.

DATASET

The dataset consisted of approximately 60 years of daily cotton prices (9,120 observations from 1972-2010) in which the prices were adjusted using the Consumer Price Index (CPI).

Figure 1. Cotton adjusted prices (1979-2011)



METHODOLOGY

Figure 2. Analysis of the stationary behavior of the series

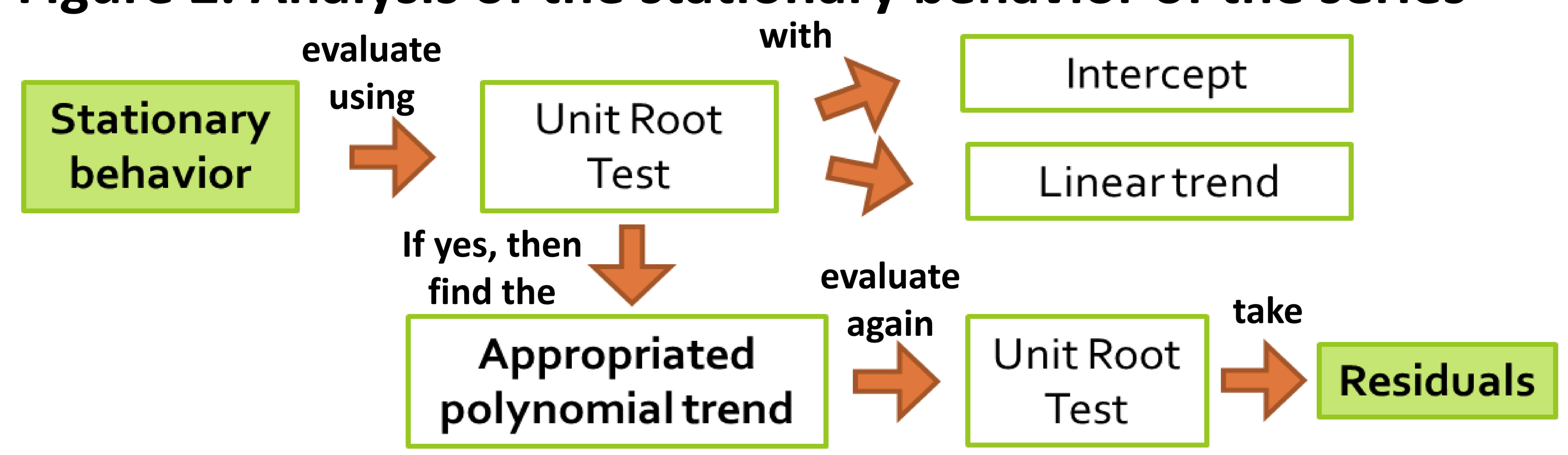


Figure 3. Analysis of the stationary behavior of the series

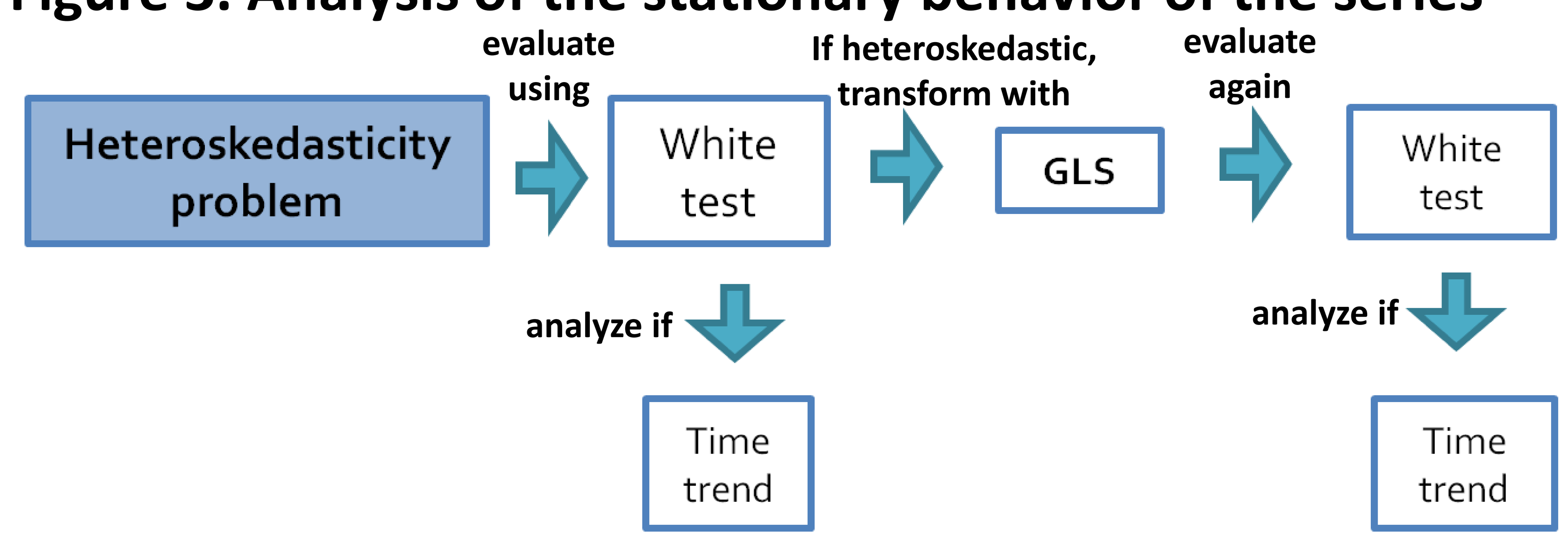
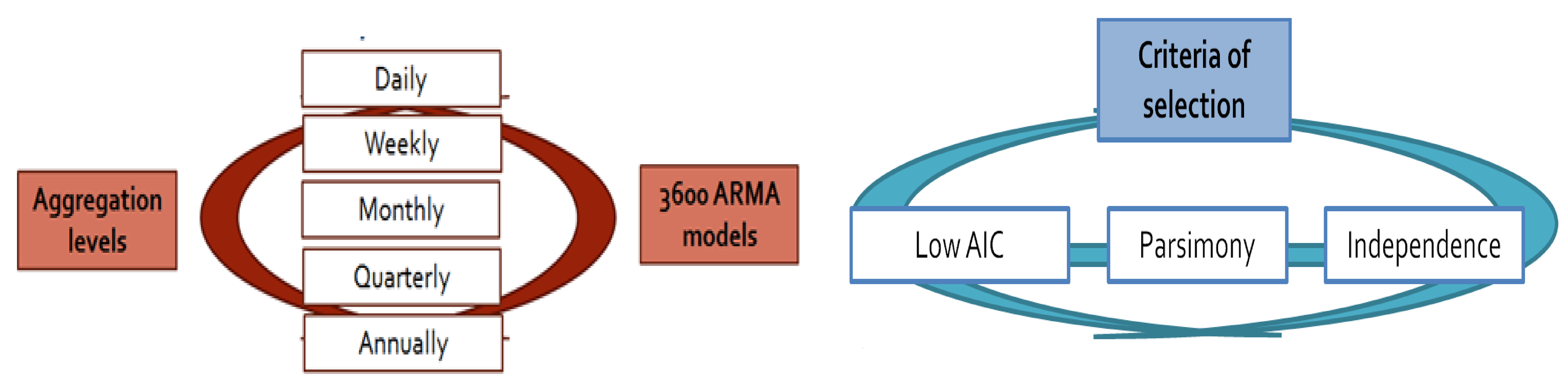


Figure 4. Criteria of selection of the true models



METHODOLOGY (II)

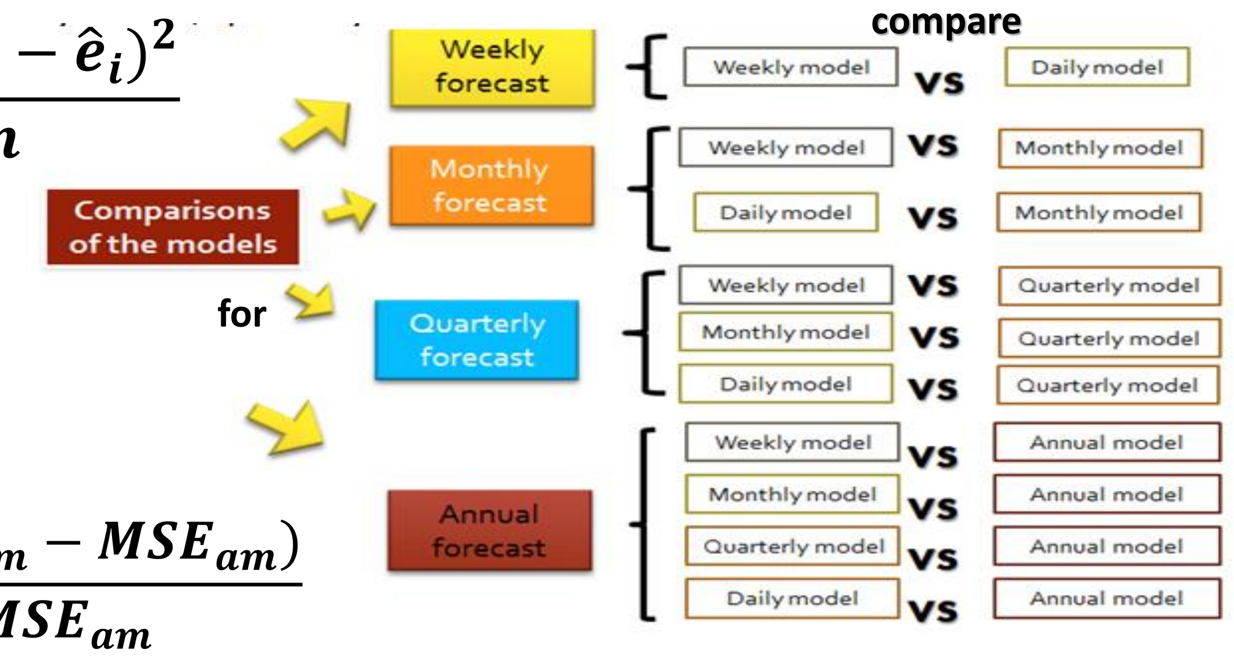
Figure 5. Comparison between the true models

$$MSE = \frac{\sum_{i=1}^{m}(e_i - \hat{e}_i)^2}{m}$$

$\hat{e}$: residual of the model
i: observation
MSE: Mean sum of squares
m: frequency
am: aggregated
dm: disaggregated

Comparison based on

$$\%\Delta MSE = \frac{(MSE_{dm} - MSE_{am})}{MSE_{am}}$$



RESULTS

Table 1. Best ARMA Models per aggregation

Cotton	AIC[1]	P[2]	Q[3]	42[4]	48[4]	P+Q[5]
Daily	-4.3207	27	9	0.4813	0.8466	36

Cotton	AIC[1]	P[2]	Q[3]	24[4]	48[4]	96[4]	240[4]	600[4]	P+Q[5]
Weekly	-2.0367	6	4	0.9871	0.9051	0.9414	0.9990	1.0000	10

Cotton	AIC[1]	P[2]	Q[3]	12[4]	24[4]	72[4]	120[4]	144[4]	P+Q[5]
Monthly	0.0046	2	4	0.9071	0.9772	0.9839	0.9845	0.9996	6

Cotton	AIC[1]	P[2]	Q[3]	4[4]	8[4]	12[4]	24[4]	60[4]	P+Q[5]
Quarterly	0.1510	3	0	0.8875	0.5708	0.3967	0.7675	0.9319	3

Commodity	AIC[1]	P[2]	Q[3]	2[4]	4[4]	8[4]	10[4]	12[4]	P+Q[5]
Daily	0.0743	1	1	0.9977	0.9847	0.9965	0.9884	0.9851	2

[1] AIC = Akaike Criterion. [2] P = Autoregressive component. [3] Q = Moving average component
[4] 12, 24, 72, 120, 144: P-value for Box-Pierce autocorrelation test at the correspondent lag.
[5] P+Q = Parsimony criterion

Table 2. Out-of-sample forecasting results for cotton

Model 1 v.s. Model 2	MSE Model 1	MSE Model 2	Efficiency difference
D-W vs W-W[1]	0.06978	0.02956	-136.06%
D-M vs M-M[2]	0.05551	0.03379	-64.28%
D-Q vs Q-Q[3]	0.05311	0.09472	43.93%
D-A vs A-A[4]	0.08805	0.19521	54.89%
W-M vs M-M[5]	0.02709	0.03379	19.83%
W-Q vs Q-Q[6]	0.06082	0.09472	35.79%
W-A vs A-A[7]	0.06686	0.19521	65.75%
M-Q vs Q-Q[8]	0.05379	0.09472	43.21%
M-A vs A-A[9]	0.07848	0.19521	59.80%
Q-A vs A-A[10]	0.08885	0.19521	54.49%

D-M v.s. M-M refers to a comparison between the MSE of the monthly forecast from the daily model (MSE Model1) and the MSE of the monthly forecasts from the monthly model (MSE Model 2).

CONCLUSIONS

The results suggested that overall, disaggregation leads to gains in efficiency; which would be consistent with the results of the theoretical studies of Tiao (1972), Koreisha and Fang (2004). Finally, the weekly model was the most efficient in forecasting the cotton prices. These results are important for cotton farmers because it could lead to better investment and hedging strategies.