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Agricultural Productivity Adjusted for Environmental Bads in Great Plains: Redux

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Agricultural Productivity in Great Plains: Redux

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OBJECTIVE

- To update estimates agricultural productivity growth in four Great Plains States: Kansas, Nebraska, Oklahoma, and South Dakota.

DATA

- The USDA's state-level productivity data for 1960-2004 was used for this study.
- The dataset of prices and quantities of two outputs (crops and livestock) and four input (capital, labor, land, and materials) in each state in each year.

METHODS

- Malmquist productivity index(MPI):

$$m_o(q_s, q_t, X_s, X_t) = \frac{d_o^t(q_t, X_t)}{d_o^s(q_s, X_s)} \left[\frac{d_o^s(q_t, X_t)}{d_o^t(q_t, X_t)} \times \frac{d_o^s(q_s, X_s)}{d_o^t(q_s, X_s)} \right]^{0.5}$$

- Parametric Malmquist productivity index(MPI-para):

$$\ln(D_o(x, y)) = \alpha_o + \sum_{i=1}^M \alpha_i \ln(y_i) + \sum_{j=1}^N \beta_j \ln(x_j) + \frac{1}{2} \sum_{i=1}^M \sum_{i'=1}^M \alpha_{ii'} \ln(y_i) \ln(y_{i'}) + \frac{1}{2} \sum_{j=1}^N \sum_{j'=1}^N \beta_{jj'} \ln(x_j) \ln(x_{j'}) + \frac{1}{2} \sum_{i=1}^M \sum_{j=1}^N \gamma_{ij} \ln(y_i) \ln(x_j) + \mu_1 t + \frac{1}{2} \mu_2 t^2 + \sum_{i=1}^M \lambda_i \ln(y_i) t$$

- Färe-Primont productivity index (FPI) :

$$TFP_{hs,jt} = \frac{D_0(X_0, q_{it}, t_0) D_1(X_{hs}, q_0, t_0)}{D_0(X_0, q_{hs}, t_0) D_1(X_{it}, q_0, t_0)}$$

- The change in profitability ($dProf$) = $dTT * dTFP$

$$dTT = \frac{P_{0t}}{W_{0t}}$$

- DPIN 3.0 software used for the calculation

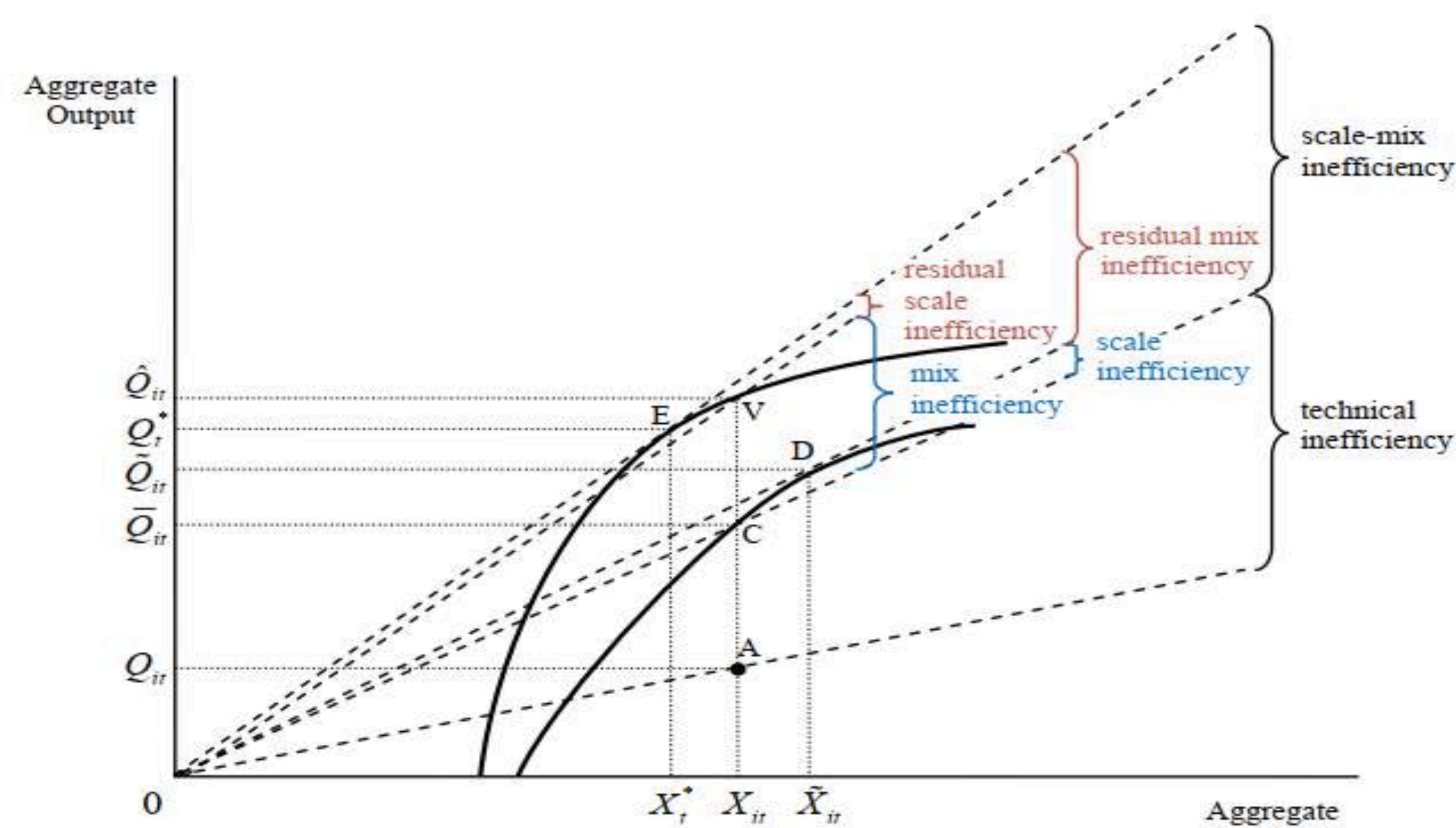


Fig 1: Output-oriented Measures of efficiency for a multiple-input multiple-output firm (Source: user guide, DPIN™ 3.1)

RESULTS

- Kansas: Färe-Primont reported higher TFP (1.40) than non-parametric MPI(1.06) and parametric MPI(1.339) (Table 1 and 2) when compared for years 1960-1996. Efficiency change was negative both for FPI and MPI-parametric.
- Nebraska: Parametric MPI reported by Rezek and Perrin(2004)(1.772) was highest followed by Färe-Primont(1.65) and non-parametric MPI(1.16).
- Oklahoma: Färe-Primont reported higher TFP(1.16) than non-parametric MPI(1.13) and parametric MPI reported by Rezek and Perrin (2004)(0.966).Efficiency change was negative both for FPI and MPI-parametric
- South Dakota: Non parametric MPI was highest (1.18) followed by Färe-Primont TFP(1.10) and parametric MPI(0.933).Efficiency change was positive for non-parametric MPI and negative both for FPI and MPI-parametric.
- Profitability ($dProf$) has decreased over the period and was highest for South Dakota (0.819) followed by Nebraska (0.79), Kansas (0.76) and Oklahoma (0.731) for period 1960-2004 (Table 3).

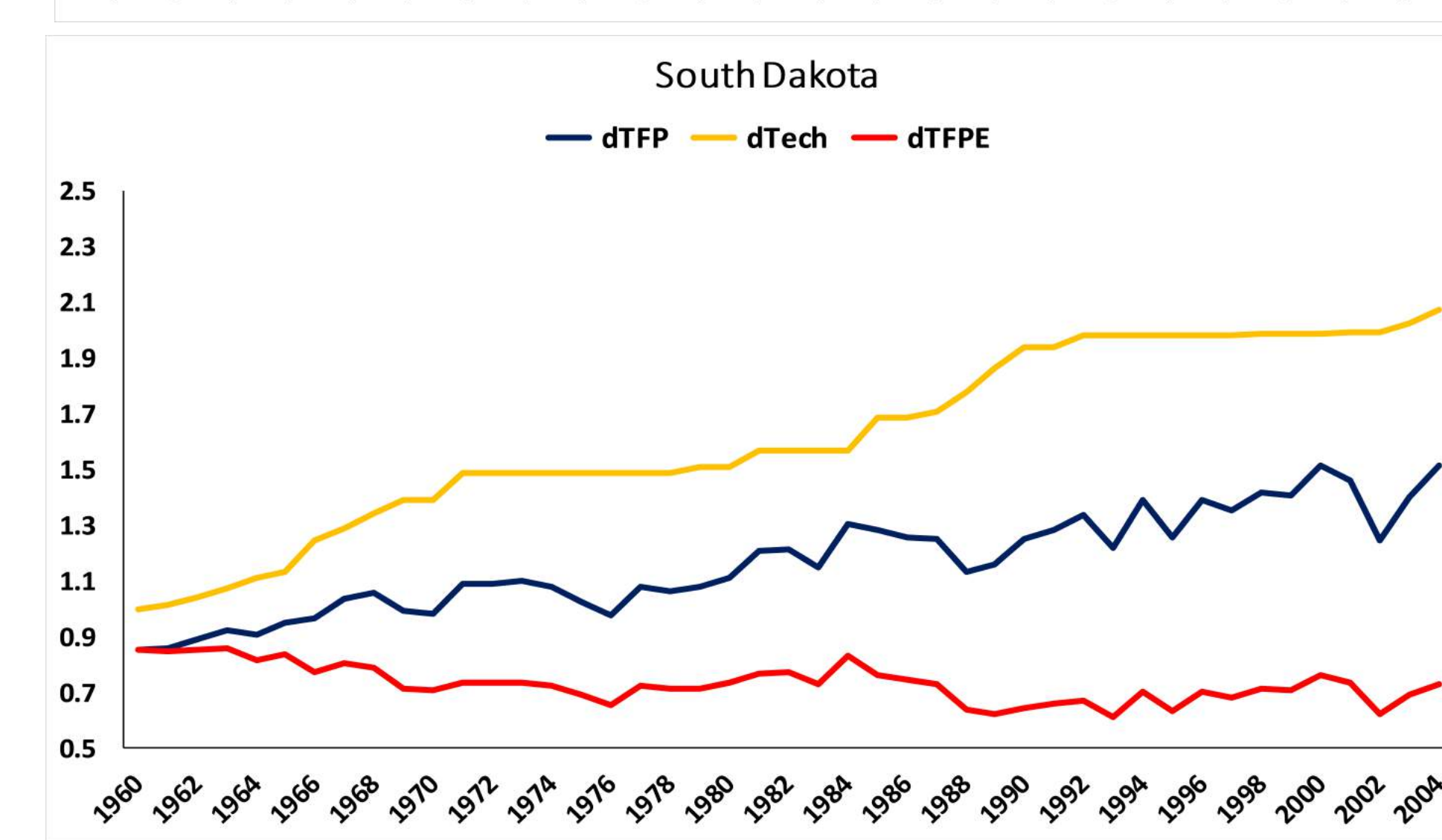
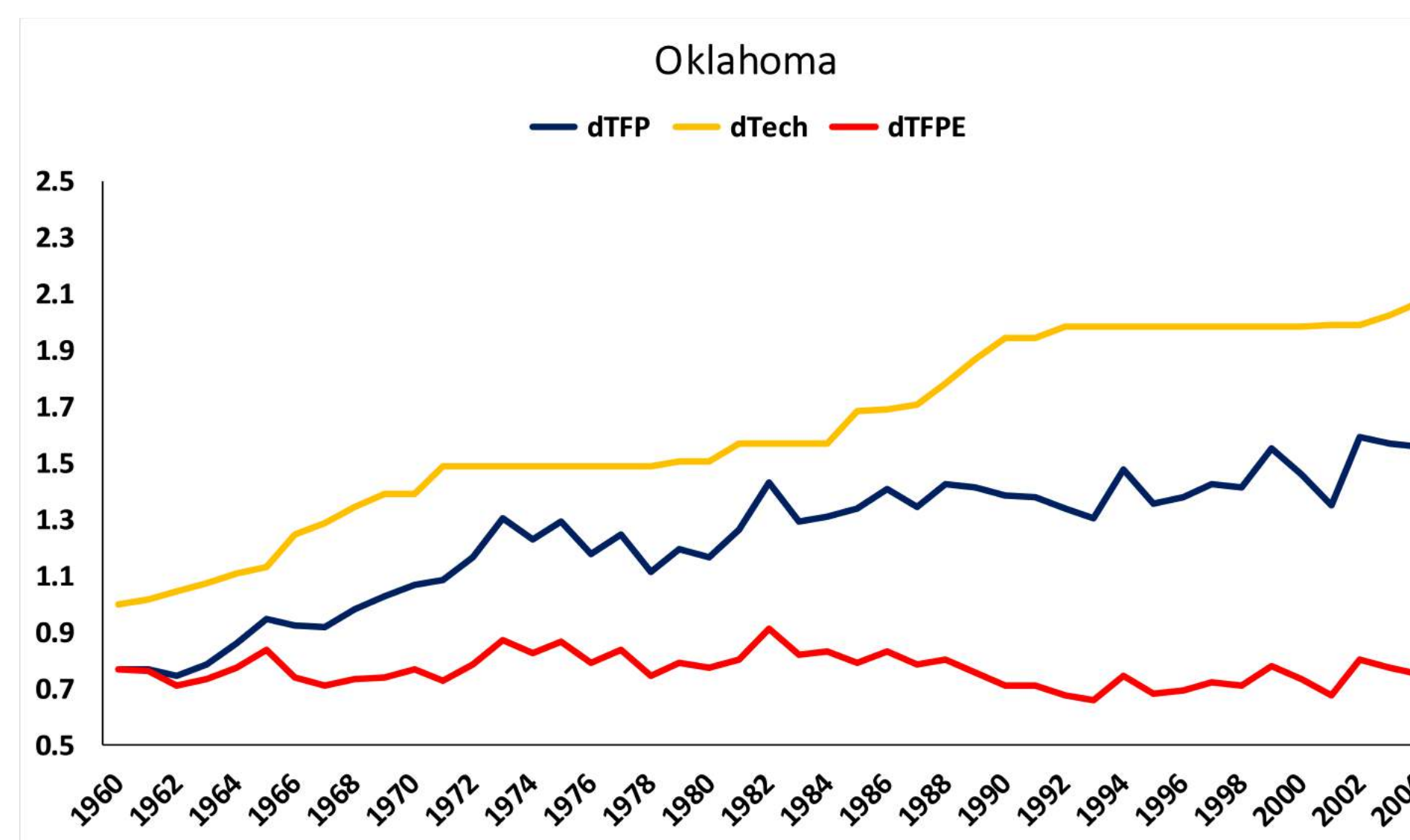
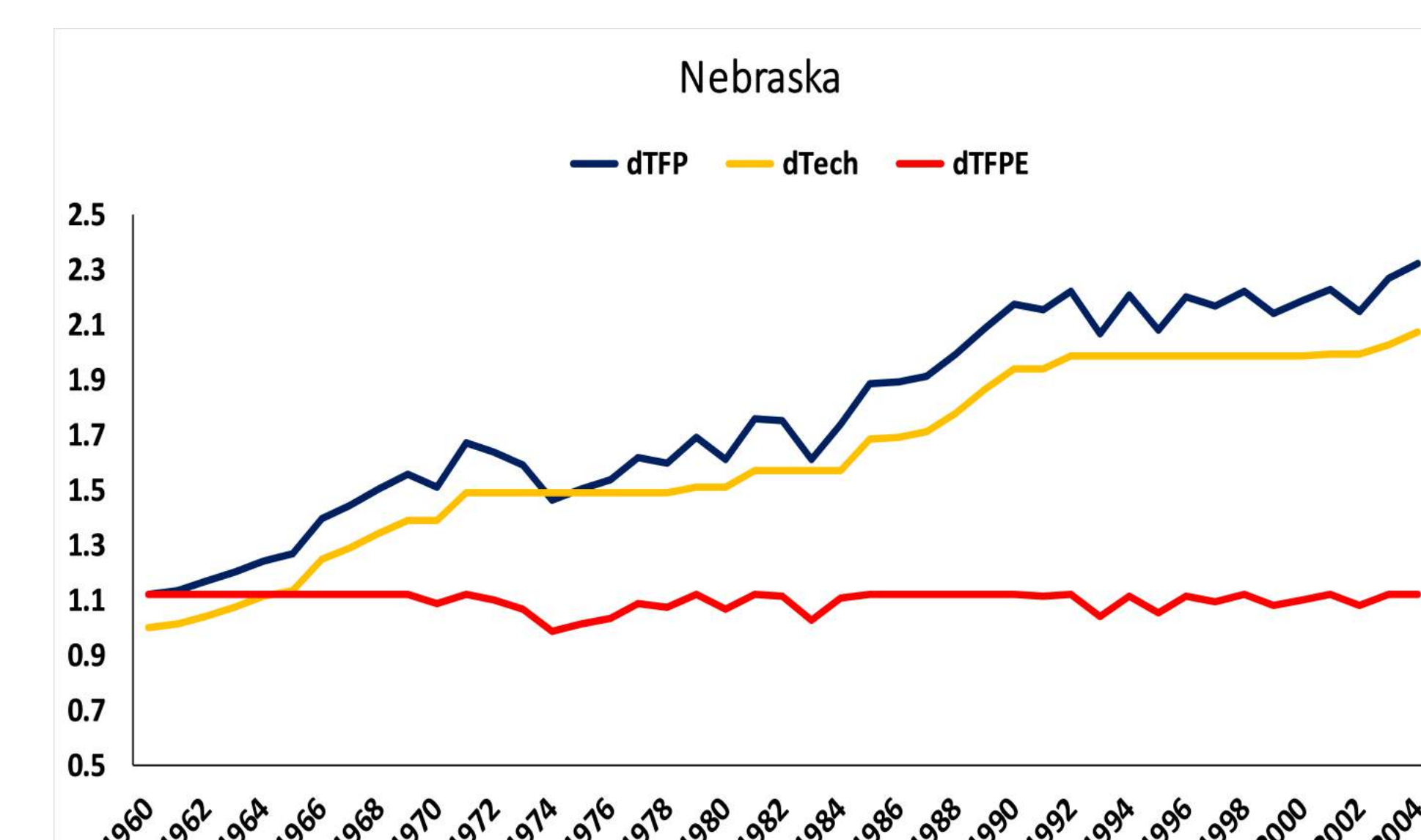
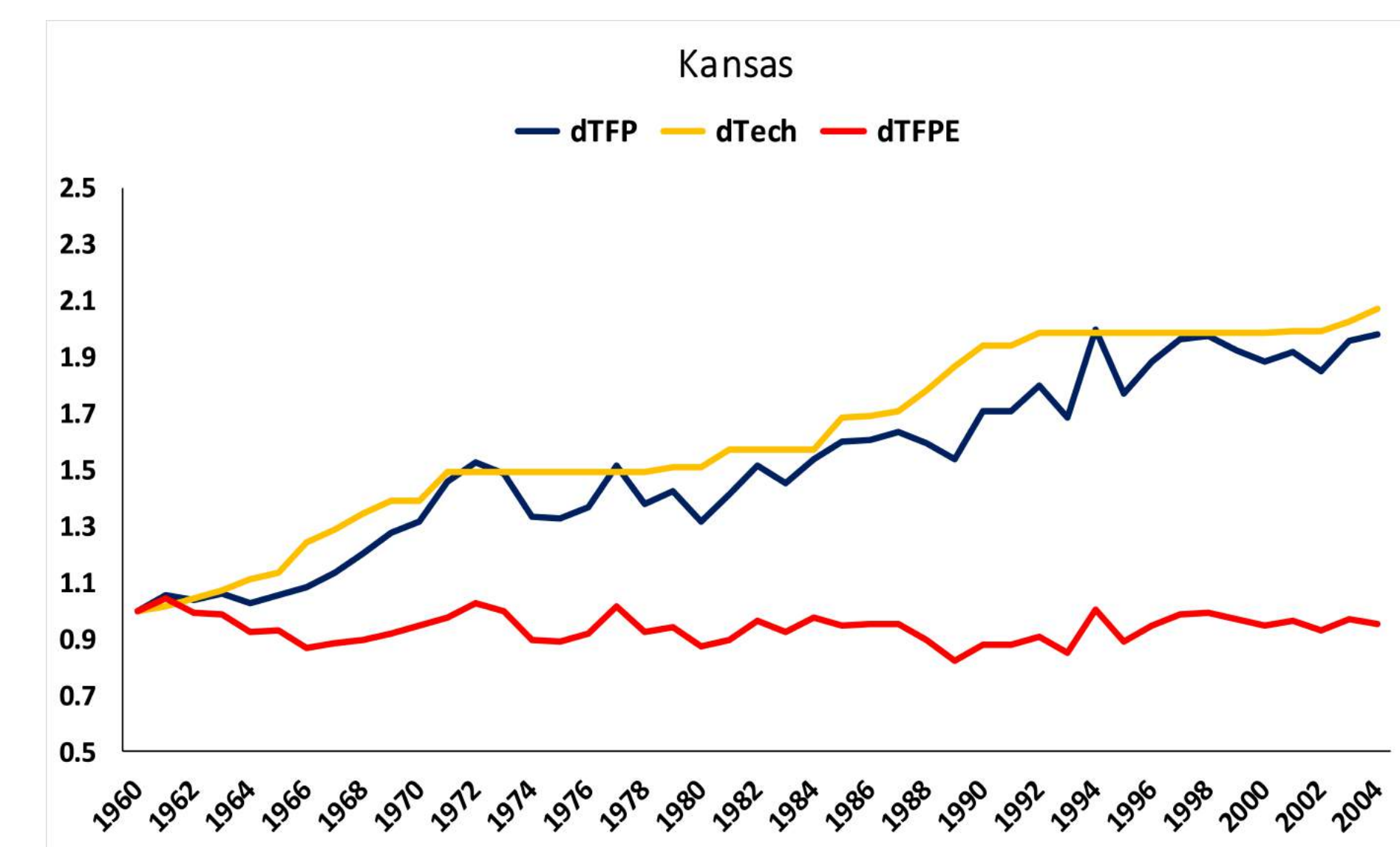


Fig 2: Cumulative Indexes Measuring Changes in FPI, Technological change and efficiency changes over the period: Relative to Kansas, 1960

Table1 : Malmquist TFP change and its decomposition over time

State	Years	Non-parametric Malmquist			Parametric Malmquist(Rezek and Perrin)			
		dTFP	dTech	dTFPE	TFP	Tech	Pure Eff	Scale Eff
Kansas	60-96	1.09	1.03	1.06	1.339	1.193	-0.200	0.346
	96-04	1.03	1.01	1.02				
	60-04	1.08	1.02	1.05				
	60-04	1.08	1.02	1.05				
Nebraska	60-96	1.16	1.07	1.08	1.772	1.290	0.143	0.340
	96-04	1.18	1.03	1.15				
	60-04	1.17	1.07	1.09				
	60-04	1.17	1.07	1.09				
Oklahoma	60-96	1.11	1.03	1.08	0.966	0.981	-0.138	0.123
	96-04	1.11	1.01	1.09				
	60-04	1.11	1.01	1.09				
	60-04	1.11	1.03	1.08				
South Dakota	60-96	1.18	1.07	1.10	0.933	1.130	-0.182	-0.016
	96-04	1.19	1.07	1.11				
	60-04	1.18	1.07	1.11				
	60-04	1.18	1.07	1.11				

Table2 : The Färe-Primont productivity index (FPI) and its decomposition

State	Years	Färe-primont			Components of Efficiency Change				
		dTFP	dTech	dTFPE	dOTE	dOSE	dOME	dROSE	dOSME
Kansas	60-96	1.40	1.50	0.93	0.96	0.99	0.99	0.98	0.97
	96-04	1.93	2.00	0.96	0.94	1.00	0.97	1.06	1.03
	60-04	1.49	1.58	0.94	0.96	0.99	0.98	1.00	0.98
	60-04	1.49	1.58	0.94	0.96	0.99	0.98	1.00	0.98
Nebraska	60-96	1.65	1.50	1.10	1.00	1.00	1.00	1.10	1.10
	96-04	2.21	2.00	1.10	1.00	1.00	1.00	1.11	1.10
	60-04	1.74	1.58	1.10	1.00	1.00	1.00	1.10	1.10
	60-04	1.74	1.58	1.10	1.00	1.00	1.00	1.10	1.10
Oklahoma	60-96	1.16	1.50	0.77	0.99	0.97	1.00	0.78	0.77
	96-04	1.49	2.00	0.74	1.00	0.97	1.00	0.74	0.74
	60-04	1.21	1.58	0.76	0.99	0.97	1.00	0.77	0.77
	60-04	1.21	1.58	0.76	0.99	0.97	1.00	0.77	0.77
South Dakota	60-96	1.10	1.50	0.73	0.98	0.95	0.98	0.76	0.75
	96-04	1.41	2.00	0.71	0.97	0.98	0.99	0.73	0.73
	60-04	1.15	1.58	0.73	0.98	0.96	0.98	0.76	0.74
	60-04	1.15	1.58	0.73	0.98	0.96	0.98	0.76	0.74

Table:3 Changes in profitability, terms of trade and total factor productivity

State	Years	dProf	dTT	dTFP	State	Years	dProf	dTT	dTFP
Kansas	60-72	0.91	0.79	1.16	Oklahoma	60-72	0.87	0.95	0.92
	73-80	0.81	0.58	1.39		73-80	0.77	0.64	1.21
	81-87	0.65	0.43	1.53		81-87	0.62	0.46	1.34
	88-96	0.73	0.42	1.74		88-96	0.67	0.49	1.38
	96-04	0.65	0.34	1.93		96-04	0.66	0.44	1.49
	60-96	0.79	0.56	1.40		60-96	0.75	0.65	1.16
60-04	0.76	0.51	1.49	60-04	0.73	0.60	1.21		
Nebraska	60-72	0.88	0.65	1.36	South Dakota	60-72	0.94	0.97	0.97
	73-80	0.79	0.50	1.57		73-80	0.83	0.78	1.06
	81-87	0.69	0.39	1.79		81-87	0.70	0.56	1.24
	88-96	0.80	0.38	2.13		88-96	0.81	0.64	1.27
	96-04	0.71	0.32	2.21		96-04	0.75	0.53	1.41
	60-96	0.80	0.49	1.65		60-96	0.83	0.76	1.10
60-04	0.79	0.45	1.74	60-04	0.82	0.71	1.15		

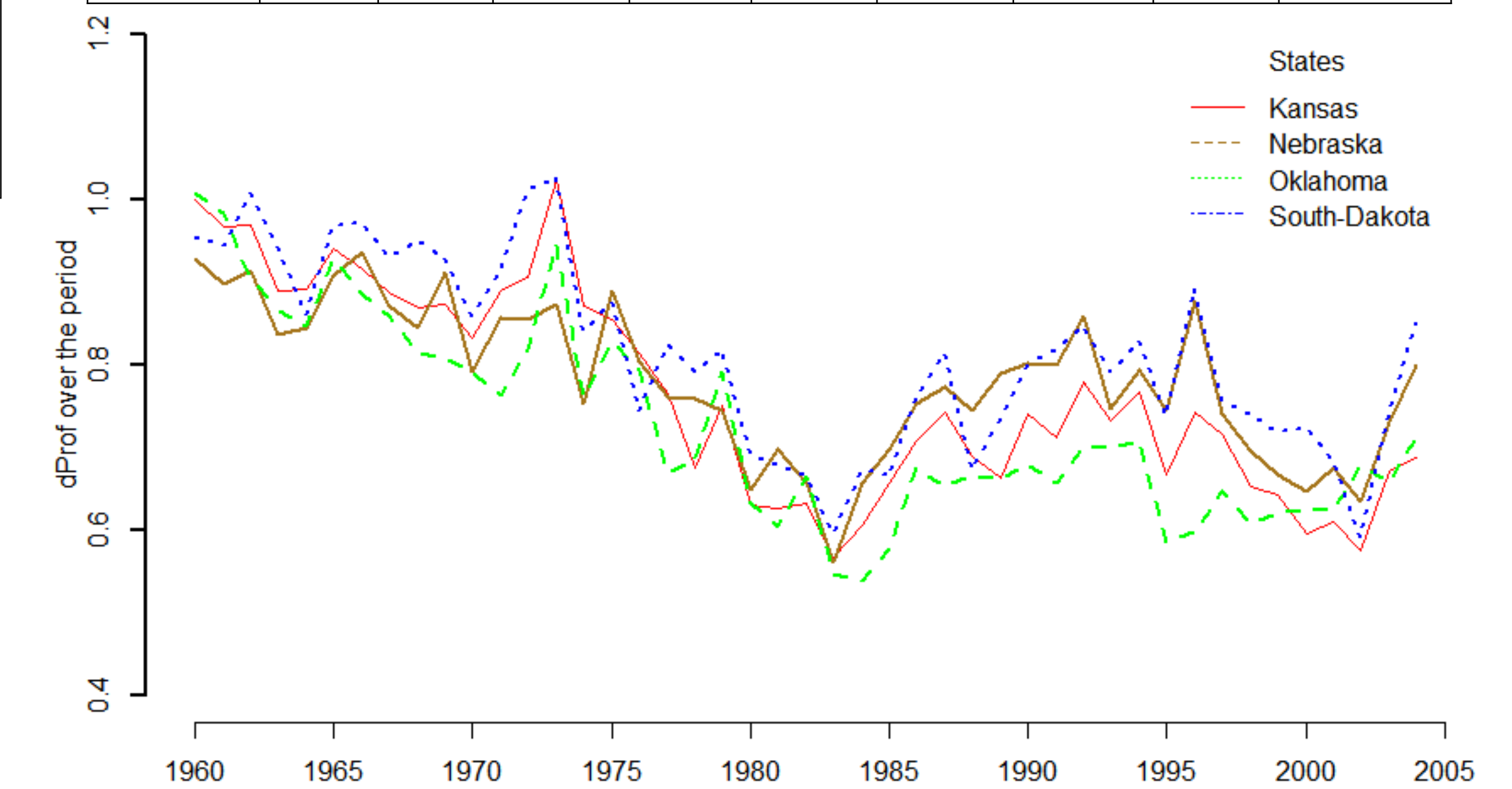


Fig 3: Indexes Measuring Changes in Profitability over the period: Relative to Kansas, 1960

CONCLUSIONS

- The Färe-primont index in general estimates higher TFP change relative to the nonparametric MPI and Higher than the parametric Malmquist index in Rezek and Perrin (2004)
- Technological change was the major contributing factor to TFP change
- Rate of change in profitability from agricultural decreased over the period in all four states
- Growth rate in terms of trade in US states over the period is higher than the increase in total factor productivity

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