

# Using the Population-Employment Ratio to Assess the County Population/Employment Projections in the SCAG Region

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*50th Annual Meeting of the Western Regional Science Association (WRS),  
Monterey, California, February 27- March 2, 2011*

# Introduction

- Why P-E Ratio?
  - dynamic change in the growth of sub-regional population and employment in the large metropolitan region.
  - Impact on transportation (e.g., the inter-county long distance commuting, transportation congestion), air quality, and energy use, etc.

# Forecasting Practice

- Kim & Hewings (2010) reviewed the regional/sub-regional growth forecasting methods and approaches for the regional transportation plan by the U.S. Metropolitan Planning Organizations (MPOs), and finds that the existing approaches do not properly reflect the population-employment relationship in a multi-level forecast modeling framework.
- The limited consideration of population-employment relationship at the sub-regional level might result in unreasonable projections of sub-regional population or employment, which might lead to the skewed allocation of the future regional transportation investment among the sub-regions.
- The consideration of population-employment relationship has not been well documented during the regional and sub-regional population and employment projections in a multi-county metropolitan region, but it has been a key consideration and criteria to produce the technically sound and politically acceptable population or employment projections due to its future region wide policy implications for the inter-county long distance commuting, transportation congestion, air quality, and energy use, etc.
- In practice, sub-regional stakeholders in the outlying subregions tend to push for more and faster employment growth than happened in the recent past, while maintaining a conservative perspective of the future regional and sub-regional population growth.

# Empirical Research:

## does job follow population or vice versa?

- The majority of the empirical studies tend to support the hypotheses that *jobs follow people* (Steinnnes, 1977; Cook, 1978; Mills and Price, 1984; Thurston and Yezer, 1994; Boarnet, 1994; Glaeser and Kahn, 2001).
- Hoogstar et al (2005) finds that popular belief is inconclusive based on the review of 308 empirical study results in the literature. They conclude that the spatial characteristics of data, model specification, and variable measurements would affect the research outcomes.
- The findings of the majority of the empirical studies imply that the sub-regional population-employment ratio gap among subregions across the region would *converge toward the regional average* from the long term perspective.
- However, theoretical and empirical urban models generally tends to accept and use the '*population follows jobs*' hypothesis as a major assumption for modeling process. Probably the approach is determined not because of its theoretically and empirically sound foundation but because of a *convenient simplification* to make difficult models easier to solve (White, 1999).

# Research Design

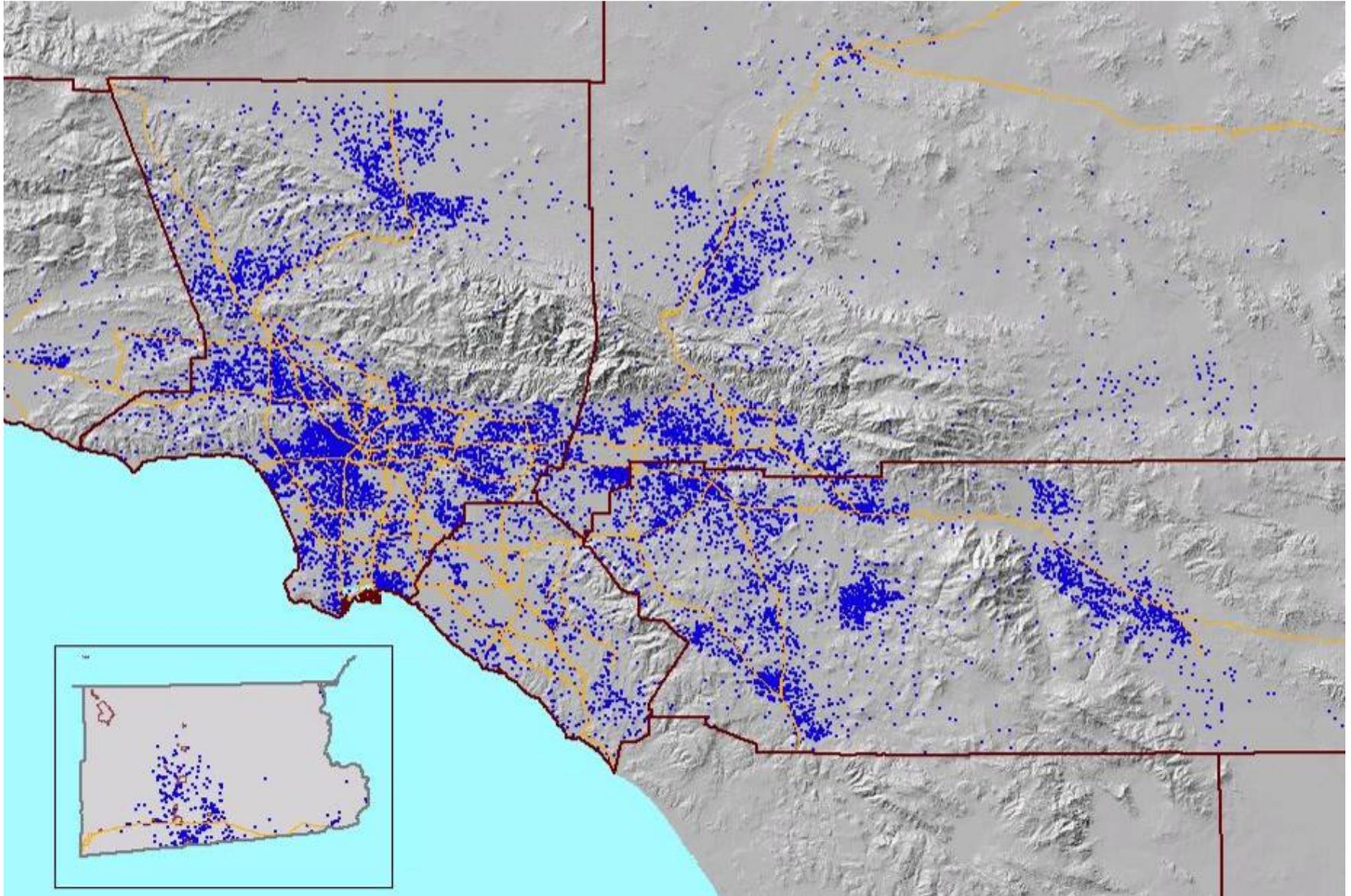
- Research Questions:
  - if there has been and will be any convergence of population-employment ratio gap among counties across the SCAG region from the long term temporal perspective
  - if there could be an econometric modeling approach toward developing the county level P-E ratio projections in the SCAG Region
- Study Area:
  - Six Counties in the SCAG Region

# SCAG Region Quick Facts



- 38,000 square miles
- 6 counties, 190 cities
- 19 million residents
- 15th largest economy in the world

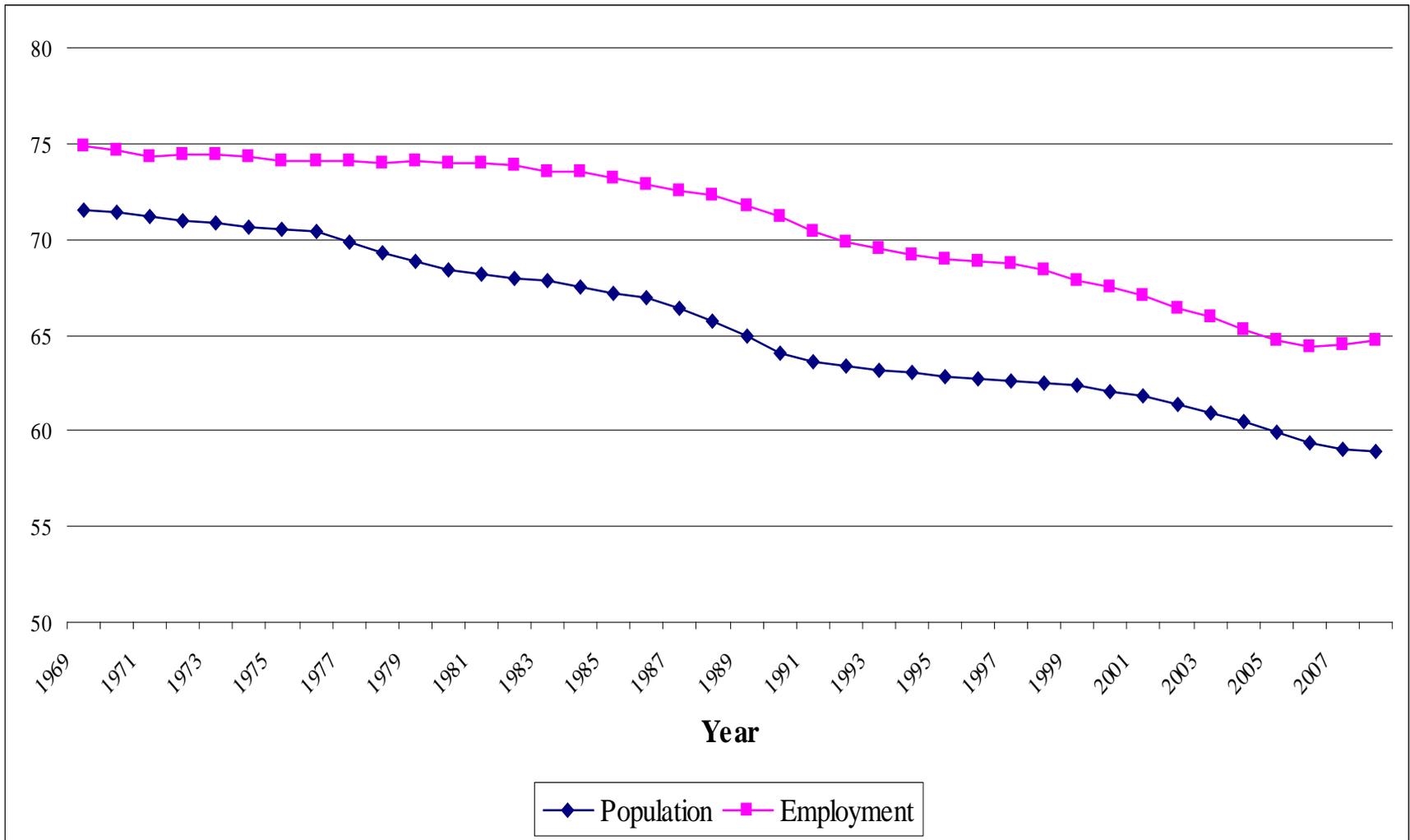
# SCAG Region's Household Growth 2003-2035



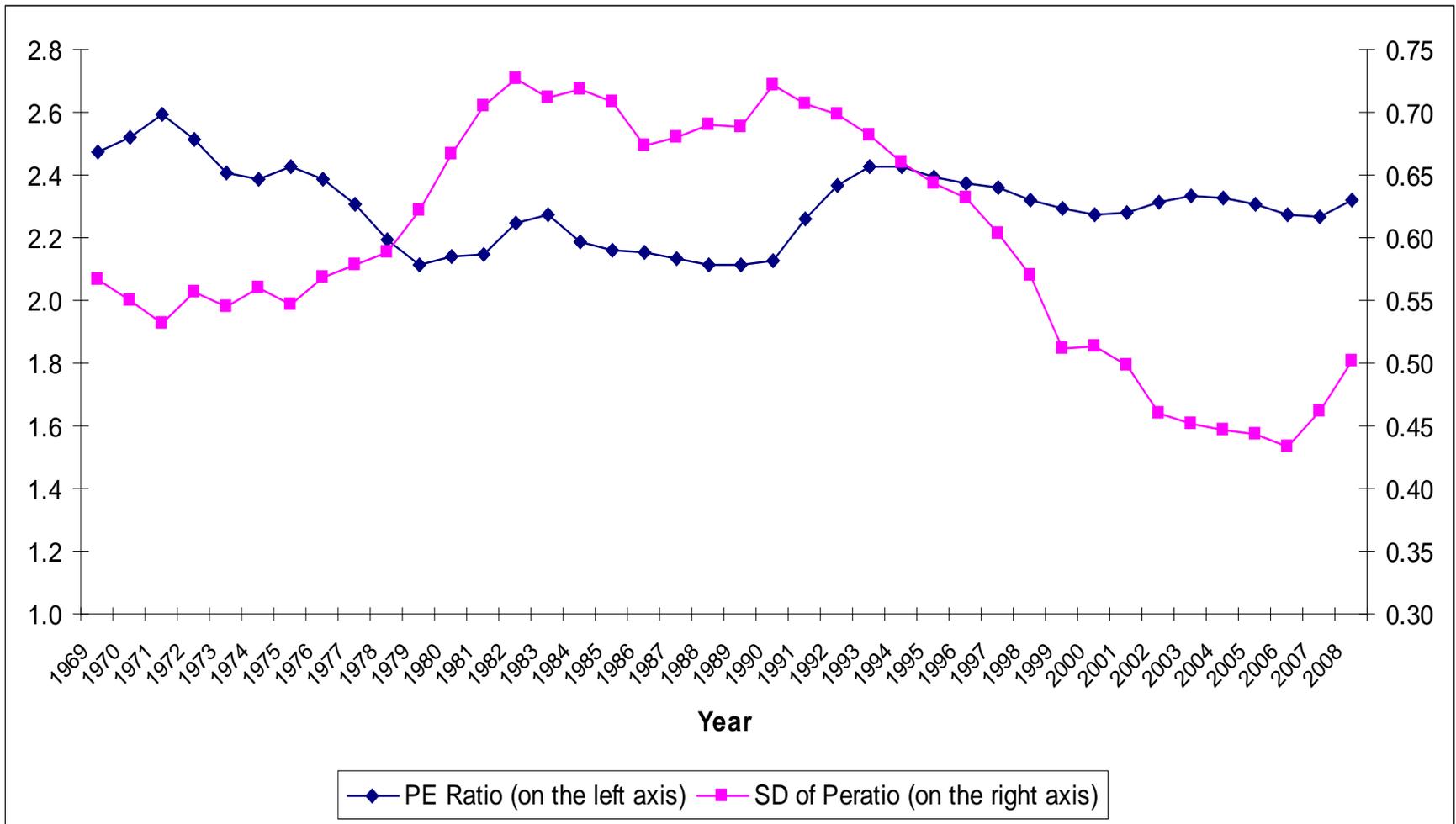
# Research Design - Continued

- Research Methods
  - Use Vector Autoregression (VAR) to project county level P-E ratios in the multi-county SCAG region. The VAR approach is attractive because it can capture the changing relationship of the county level P-E ratios and regional economic measures over time.
  - The long-term observed trends of population and employment ratio in the region and its subregions will be modeled with or without other significant variables (e.g., regional unemployment rate) using the VAR.
  - The study uses the projected population-employment relationship to produce employment projections given population projection or to assess employment projections relative to population projection or vice versa in the multi-county SCAG region.
  - Assess the level of convergence of the sub-regional P-E ratios using Hoover Index (HI), Standard Deviation (SD), and Index of Divergence (ID)
- Data: Regional Economic Information System 1969-2008, Bureau of Economic Analysis, US Department of Commerce

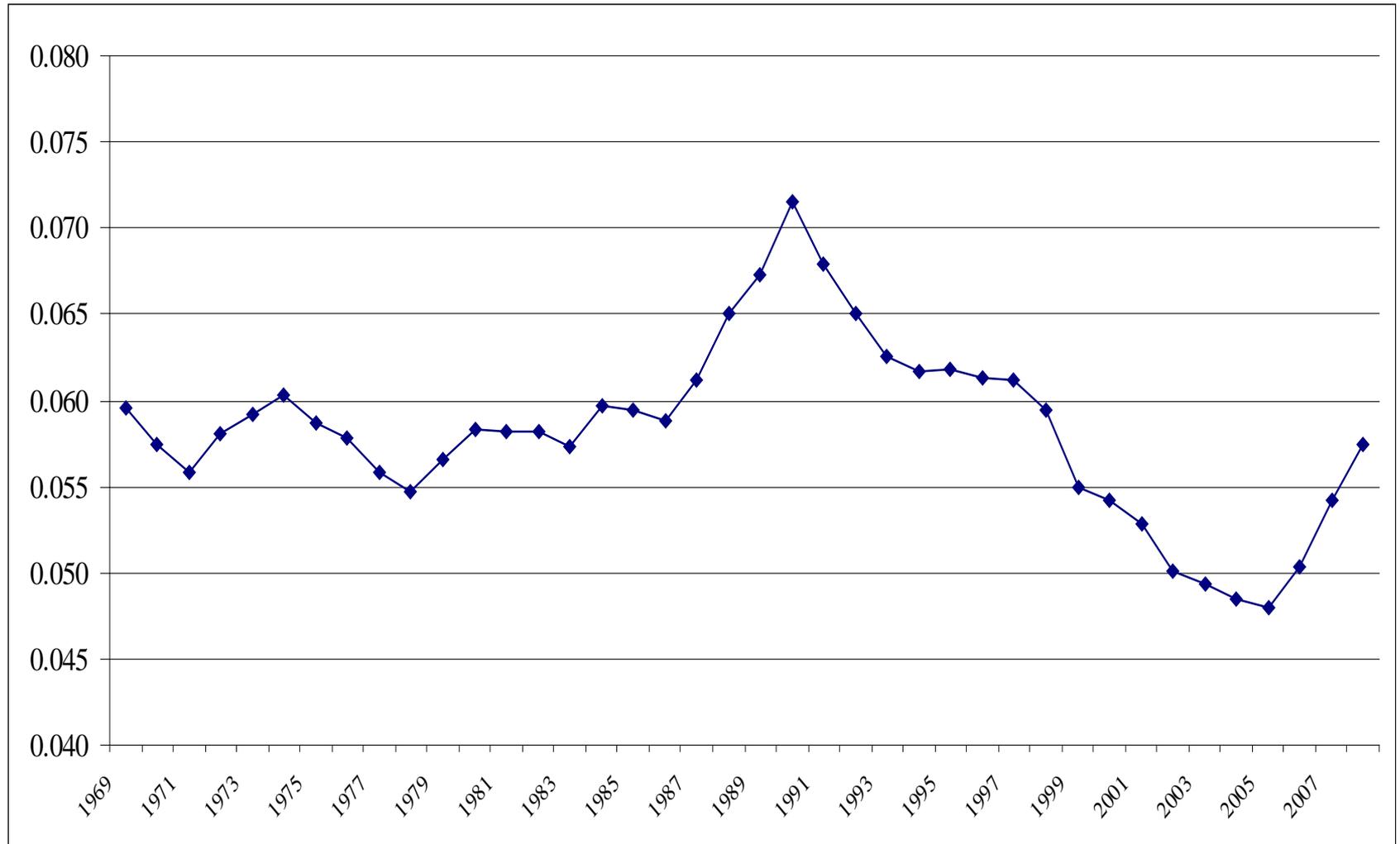
# Convergence Test: Hoover Index for Population and Employment for Six Counties in the Southern California Region, 1969-2008



# Convergence Test: Regional P-E Ratio and its Standard Deviation, 1969-2008



# Convergence Test: Index of Divergence for Population and Employment, 1969-2008



# Convergence Test

- The SCAG region, one of the largest metropolitan regions in the USA, has experienced the continuous suburbanization of population and employment for long time.
- The changing pattern of the Hoover Index for population and employment is strongly correlated. The historical data suggests that there might be an overall convergence (and a clear convergence between 1990 and 2006) of the P-E ratio gap among counties in the region, but there is always a short term adjustment and fluctuation probably associated with different pattern of population and employment growth.
- The Index of Divergence (ID) supports the overall convergence pattern with a short term fluctuation. The changing pattern of the regional P-E ratio might be related to other economic measures (e.g., regional unemployment rate).

# VAR (Vector Autoregression) Model: Description of Variables

Table 1. Descriptive Statistics of the Variables

	Mean	Min.	Max.	Std. Dev.
<b><u>Endogenous Variables</u></b>				
Imperial County P-E Ratio	2.584	2.145	2.814	0.206
Los Angeles County P-E Ratio	2.137	1.974	2.283	0.120
Orange County P-E Ratio	2.074	1.833	2.819	0.229
Riverside County P-E Ratio	3.268	2.974	3.669	0.196
San Bernardino County P-E Ratio	3.100	2.799	3.339	0.164
Ventura County P-E Ratio	2.669	2.323	3.140	0.252
<b><u>Exogenous Variables</u></b>				
SCAG Region P-E Ratio	2.268	2.110	2.428	0.101
SCAG Region Unemployment Rate	6.824	4.606	9.699	1.575

Note: Total observations are 34.

# VAR (Vector Autoregression) Model:

VAR (2) Model is adopted

$$pe_t^i = c + A_1 pe_{t-1}^i + A_2 pe_{t-2}^i + B_1 pe_t^{scag} + B_2 unemp_t^{scag} + \varepsilon_{it}$$

- 1)  $pe_t^i$  = a P-E ratio of endogenous variable ( $i$  = Imperial, Los Angeles, Orange, Riverside, San Bernardino, and Ventura)
- 2)  $pe_t^{scag}$  = a P-E ratio of SCAG region
- 3)  $unemp_t^{scag}$  = an unemployment rate of SCAG

# VAR (2) Model Estimation Results:

Table 2. VAR (2) Model Results

	Imperial	Los Angeles	Orange	Riverside	San Bernardino	Ventura
Constant	0.435 (2.173)	-0.145 (0.192)	-0.891 ** (0.408)	2.221 ** (1.033)	1.257 (0.933)	-0.544 (0.702)
Imperial(t-1)	0.364 (0.246)	0.009 (0.022)	-0.012 (0.046)	-0.076 (0.117)	0.015 (0.106)	0.141 * (0.079)
Imperial(t-2)	-0.322 (0.2)	-0.011 (0.018)	0.036 (0.038)	0.091 (0.095)	0.111 (0.086)	-0.046 (0.065)
Los Angeles (t-1)	1.425 (0.958)	0.059 *** (0.085)	-1.075 *** (0.18)	-1.418 *** (0.455)	-0.928 ** (0.411)	-1.596 *** (0.309)
Los Angeles (t-2)	-0.412 (0.838)	-0.27 *** (0.074)	0.452 *** (0.157)	0.727 * (0.398)	-0.167 (0.36)	0.946 *** (0.271)
Orange (t-1)	-1.016 (0.948)	-0.256 *** (0.084)	0.701 *** (0.178)	0.632 (0.451)	0.142 (0.407)	0.637 ** (0.306)
Orange (t-2)	-0.246 (0.908)	0.125 (0.08)	-0.093 (0.17)	-0.513 (0.431)	0.324 (0.39)	-0.378 (0.293)
Riverside (t-1)	-0.075 (0.579)	-0.123 ** (0.051)	-0.076 (0.109)	1.144 *** (0.275)	0.601 ** (0.249)	0.219 (0.187)
Riverside (t-2)	0.13 (0.696)	0.013 (0.061)	-0.169 (0.13)	-0.155 (0.331)	-0.579 * (0.299)	-0.705 *** (0.225)
San Bernardino (t-1)	-1.194 ** (0.571)	-0.042 (0.05)	0.21 * (0.107)	-0.12 (0.271)	0.544 ** (0.245)	0.151 (0.184)
San Bernardino (t-2)	1.138 * (0.64)	0.052 (0.057)	-0.035 (0.12)	-0.191 (0.304)	0.277 (0.275)	0.387 * (0.207)
Ventura (t-1)	1.032 (0.615)	0.04 (0.054)	0.051 (0.115)	-0.463 (0.292)	-0.286 (0.264)	0.673 *** (0.199)
Ventura (t-2)	-0.279 (0.726)	-0.021 (0.064)	0.102 (0.136)	0.209 (0.345)	-0.118 (0.312)	0.054 (0.234)
SCAG Region	0.122 (1.109)	1.038 *** (0.098)	1.238 *** (0.208)	0.165 (0.527)	0.588 (0.476)	0.812 ** (0.358)
unemp_SCAG	0.033 (0.042)	-0.005 (0.004)	-0.001 (0.008)	0.043 ** (0.02)	0.002 (0.018)	-0.008 (0.014)
R-squared	0.913	0.998	0.995	0.983	0.981	0.994
Adj. R-squared	0.841	0.997	0.992	0.97	0.965	0.989
Log Likelihood	48.08	125.711	101.628	71.884	75.126	84.243

Note: 1. Value in parenthesis stands for standard error of each coefficient estimated.

2. \*: 10% significant level    \*\*: 5% significant level    \*\*\*: 1% significant level

# VAR (2) Model Estimation Results: Continued

Table 3. Residual Correlation Matrix

	<b>Imperial</b>	<b>Los Angeles</b>	<b>Orange</b>	<b>Riverside</b>	<b>San Bernardino</b>	<b>Ventura</b>
<b>Imperial</b>	1	0.234	-0.215	-0.219	-0.376	-0.094
<b>Los Angeles</b>	0.234	1	-0.771	-0.638	-0.447	-0.47
<b>Orange</b>	-0.215	-0.771	1	0.41	0.102	0.449
<b>Riverside</b>	-0.219	-0.638	0.41	1	0.479	0.33
<b>San Bernardino</b>	-0.376	-0.447	0.102	0.479	1	-0.154
<b>Ventura</b>	-0.094	-0.47	0.449	0.33	-0.154	1

# VAR (2) Model Estimation Results: Continued

- Imperial County:
  - 1) negatively correlated with the first and second lags for a P-E ratio of San Bernardino (If a P-E ratio of Imperial increases, a P-E ratio of San Bernardino decreases, or vice versa.).
- Los Angeles County:
  - 1) autocorrelated with the first and second lags
  - 2) negatively correlated with the first lag for a P-E ratio of Orange and Riverside Counties (a P-E ratio of Los Angeles move toward the opposite direction with P-E ratios of Orange and Riverside)
  - 3) A P-E ratio of the SCAG region is statistically significant (one unite increase of SCAG's P-E ratio → Los Angeles' P-E ratio increase by 1.038)

# VAR (2) Model Estimation Results: Continued

- Orange County:
  - 1) autocorrelated with the first lag
  - 2) negatively correlated with the first lag of Los Angeles and positively correlated with the first lag of San Bernardino and the second lag of Los Angeles (P-E ratios of Orange and Los Angeles Counties move toward the opposite direction, but P-E ratios of Orange and San Bernardino Counties move toward the same direction.)
  - 3) A P-E ratio of the SCAG region shows a statistical significance in explaining the change of an Orange County's P-E ratio (one unit increase of SCAG's P-E ratio → Orange's P-E ratio increase by 1.238)

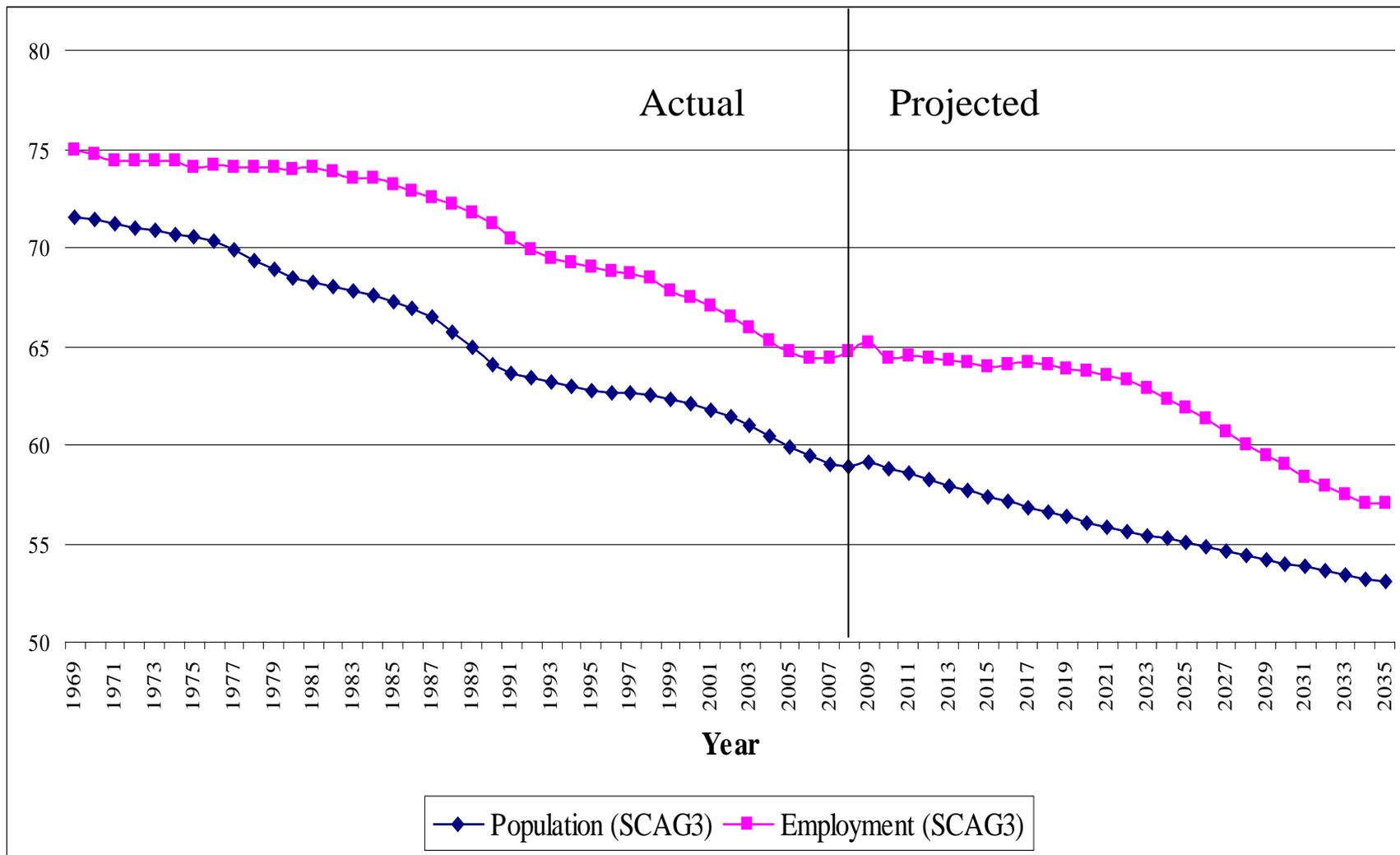
# VAR (2) Model Estimation Results: Continued

- Riverside County:
  - 1) Autocorrelation is detected at the first lag
  - 2) The first and second lags of Los Angeles are correlated with a Riverside's P-E ratio (P-E ratios of Riverside and Los Angeles Counties will move toward the same direction.)
  - 3) one percentage increase of the unemployment rate of the SCAG Region → a P-E ratio of Riverside increases by 0.043
- San Bernardino:
  - 1) autocorrelated with the first lag
  - 2) The first lag of Los Angeles and the first and second lags of Riverside have a correlation with a P-E ratio of San Bernardino (P-E ratios of San Bernardino and Los Angeles move opposite direction, however P-E ratios of San Bernardino and Riverside move same direction)

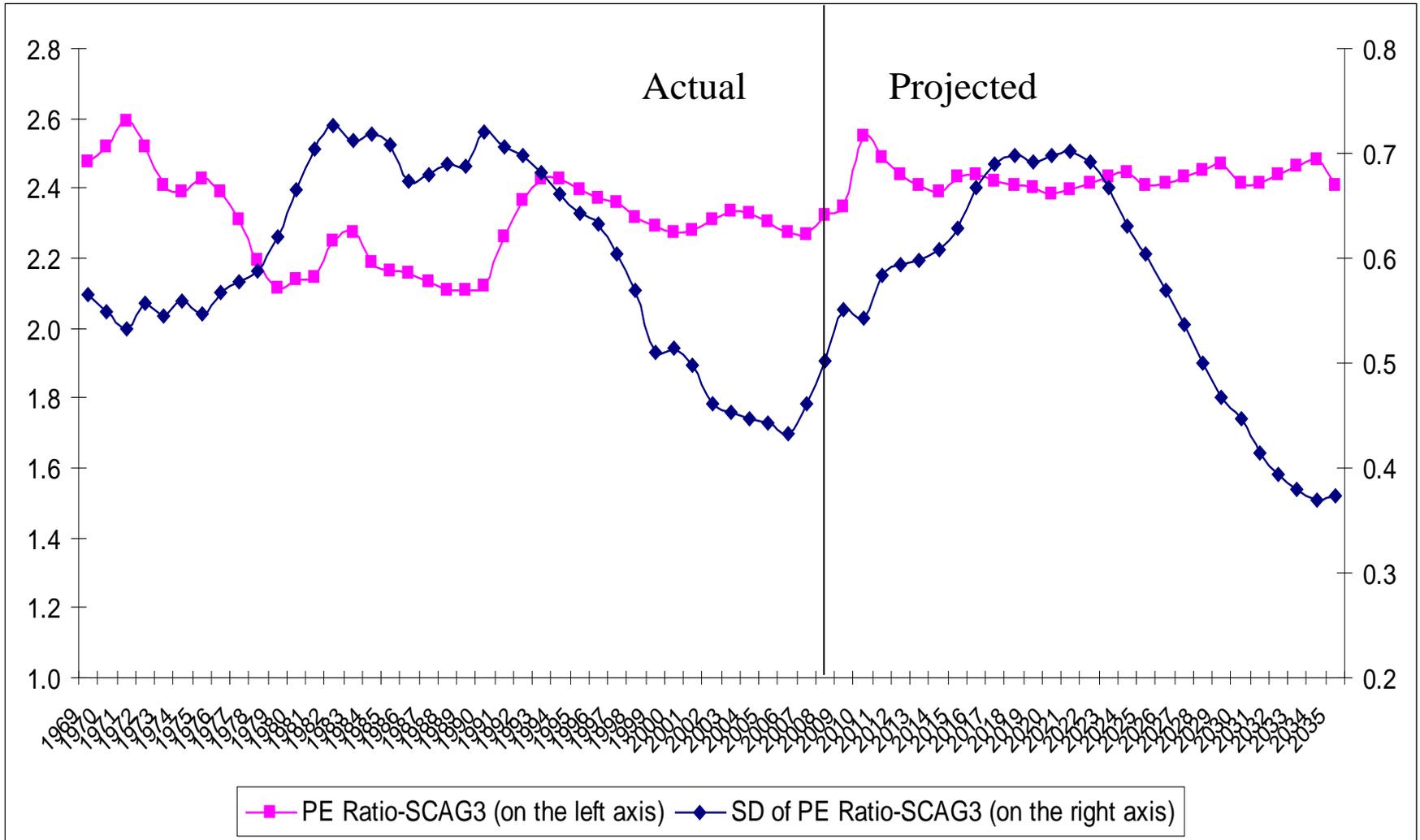
# VAR (2) Model Estimation Results: Continued

- Ventura:
  - 1) Autocorrelation exists in the first lag
  - 2) correlated with the first lags of Imperial and Orange Counties
  - 3) correlated with the first and second lags of Los Angeles County
  - 4) correlated with the second lags of Riverside and San Bernardino Counties
  - 5) A P-E ratio of SCAG Region is statistically significant at the 5% significant level (one unit increase of a P-E ratio of SCAG Region → P-E ratio of Ventura increases by 0.812)

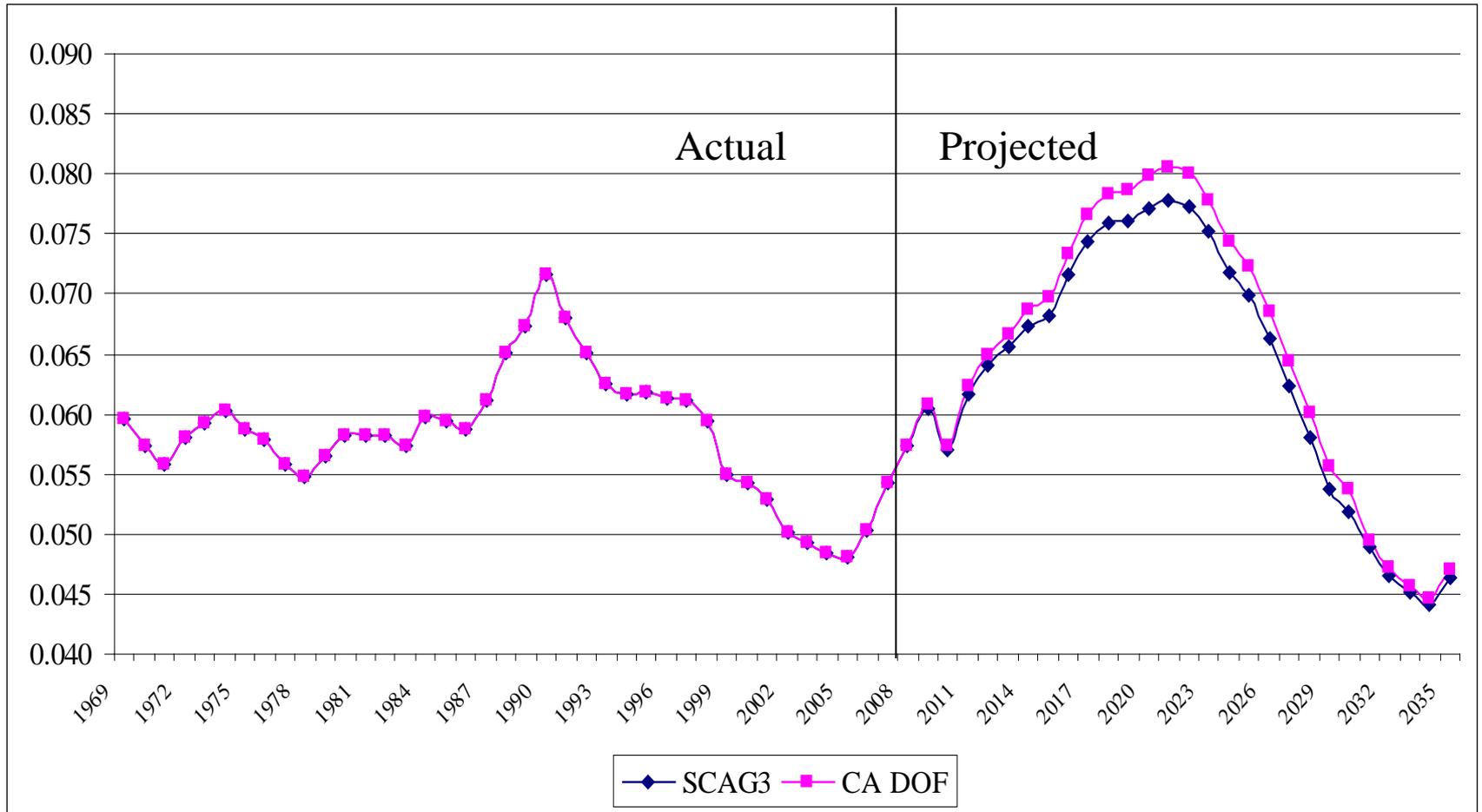
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# Using the Projected P-E Ratio to Assess County Level Employment Projections

Table 5. 2035 Population Projections by County from Major Sources

County	Caltrans <sup>1</sup>	SCAG1 <sup>3</sup>	SCAG2 <sup>3</sup>	SCAG3 <sup>3</sup>	CA DOF <sup>2</sup>	Difference (maximum- minimum)	% Difference
Imperial	294403	320446	308253	303136	308874	26043	8.8%
Los Angeles	12316250	12338619	12268448	11889870	12217857	448750	3.8%
Orange	3950189	3653988	3560402	3576235	3780688	389787	10.9%
Riverside	3465092	3596681	3565302	3396287	3799853	403566	11.9%
San Bernardino	3155167	3133799	3081909	2838320	3133313	316847	11.2%
Ventura	1105348	1013756	1005456	978978	1092557	126370	12.9%
SCAG Region	24286449	24057289	23789770	22982826	24333142	1350316	5.9%

Table 6. 2035 Employment Projections by County from Major Sources

County	Caltrans	SCAG1	SCAG2	SCAG3	CA DOF	Difference (maximum- minimum)	% Difference
Imperial	83497	132552	117772	112929		49055	58.7%
Los Angeles	5696940	5041174	5045420	4953516		743424	15.0%
Orange	2199016	1981901	1838157	1796018		402998	22.4%
Riverside	1014208	1413522	1313779	1231967		399314	39.4%
San Bernardino	984699	1254755	1093928	1076416		270056	27.4%
Ventura	447869	463227	435779	422559		40668	9.6%
SCAG Region	10426230	10287131	9844835	9593406		832824	8.7%

# Using the Projected P-E Ratio to Assess County Level Employment Projections: Continued

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Orange	2199016	1981901	1838157	1796018		402998	22.4%
Riverside	1014208	1413522	1313779	1231967		399314	39.4%
San Bernardino	984699	1254755	1093928	1076416		270056	27.4%
Ventura	447869	463227	435779	422559		40668	9.6%
SCAG Region	10426230	10287131	9844835	9593406		832824	8.7%

Table 7. 2035 Employment Projections by County Using the Projected P/E Ratio

County	Caltrans	SCAG1	SCAG2	SCAG3	CA DOF	Difference (maximum- minimum)	% Difference
Imperial	106803	116251	111828	109972	112053	9448	8.8%
Los Angeles	5078218	5087442	5058509	4902414	5037649	185028	3.8%
Orange	2081436	1925361	1876049	1884392	1992122	205387	10.9%
Riverside	1163739	1207933	1197394	1140631	1276167	135536	11.9%
San Bernardino	1181467	1173465	1154035	1062822	1173283	118645	11.2%
Ventura	510090	467822	463992	451773	504187	58317	12.9%
SCAG Region	10121753	9978275	9861807	9552004	10095463	569750	6.0%

Table 8. Percent Error of 2035 Employment Projections by County

County	Caltrans	SCAG1	SCAG2	SCAG3	CA DOF	Difference (maximum- minimum)
Imperial	28%	-12%	-5%	-3%		40.2%
Los Angeles	-11%	1%	0%	-1%		11.8%
Orange	-5%	-3%	2%	5%		10.3%
Riverside	15%	-15%	-9%	-7%		29.3%
San Bernardino	20%	-6%	5%	-1%		26.5%
Ventura	14%	1%	6%	7%		12.9%
SCAG Region	-3%	-3%	0%	0%		3.2%

# Conclusion

- This study raises two key questions about the *convergence of population-employment ratio gap among counties across the region* from the long term temporal perspective and *development of an econometric modeling approach* toward developing the county level P-E ratio projections.
- This study finds that there has been and will be suburbanization of population and employment, and an overall convergence of the P-E ratio gap among counties in the region with a short term reversal.
- The VAR approach is found useful and successfully projects the county level P-E ratios, which provide more understanding of the future spatio-temporal arrangement of population and employment in the SCAG region.
- Using five sets of independent population and employment projections from three different sources, the study finds that the relatively small county or the fast growing county tends to show the bigger errors than the large county or the slow growing county. The county level employment projections are available for the state agency (CA DOF) which projects only population projections.

# Future Research

- The future study might be needed to estimate the impacts of the changing distribution of population and employment by county in the multi-county region on inter-county commuting and related long-distance commuting flows, vehicle miles travel, gasoline use, etc.
- The current approach toward the projection of the county level population-employment ratio might be further extended to develop reasonable city level population and employment projections at the smaller level of geography (e.g., city, zipcode)
- The quantified information would help regional, sub-regional, and local planners and stakeholders to make an informed forecasting and related land use and transportation policy discussion.