In the Long Run We're All Dead – Discerning Short-Term Cyclical Trends From Medium and Long-Term Structural Changes

Determinants of Water Use and Implications for Inference and Forecasting

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Hazen and Sawyer, PC

Overview

- Attempt to organize factors that influence water use
- Show some evidence of how quickly the recent recession affected water use in some areas
- Illustrate why it is typically difficult to isolate different trends in water use
- Show some examples of how expectations of the future are affected by shocks
- Provide some concluding remarks

Cyclical Factors that Affect Water Use

- Climatic
  - Normal intra-annual weather patterns (short cycles)
  - ENSO, PDO, etc.
  - Periodic droughts
- Economic
  - Expansion (gradual or “boom”)
  - Contraction (typically pretty fast to materialize)

“Structural” Factors that Affect Water Use

- Standards
  - Increasing efficiency of water fixtures
- Regulations and codes
  - Land use
  - Structures
  - Prohibition of certain activities/timing of activities

Trend ("Drifting") Factors that Affect Water Use

- Water using attitudes/norms
- Economics and markets
  - Development patterns
  - Production patterns
  - Demographic patterns
  - Costs and prices
- Utility policies (discrete upon implementation)
  - How water is priced
  - Promotion of efficiency
- Climate

Issues for Inference and Forecasting

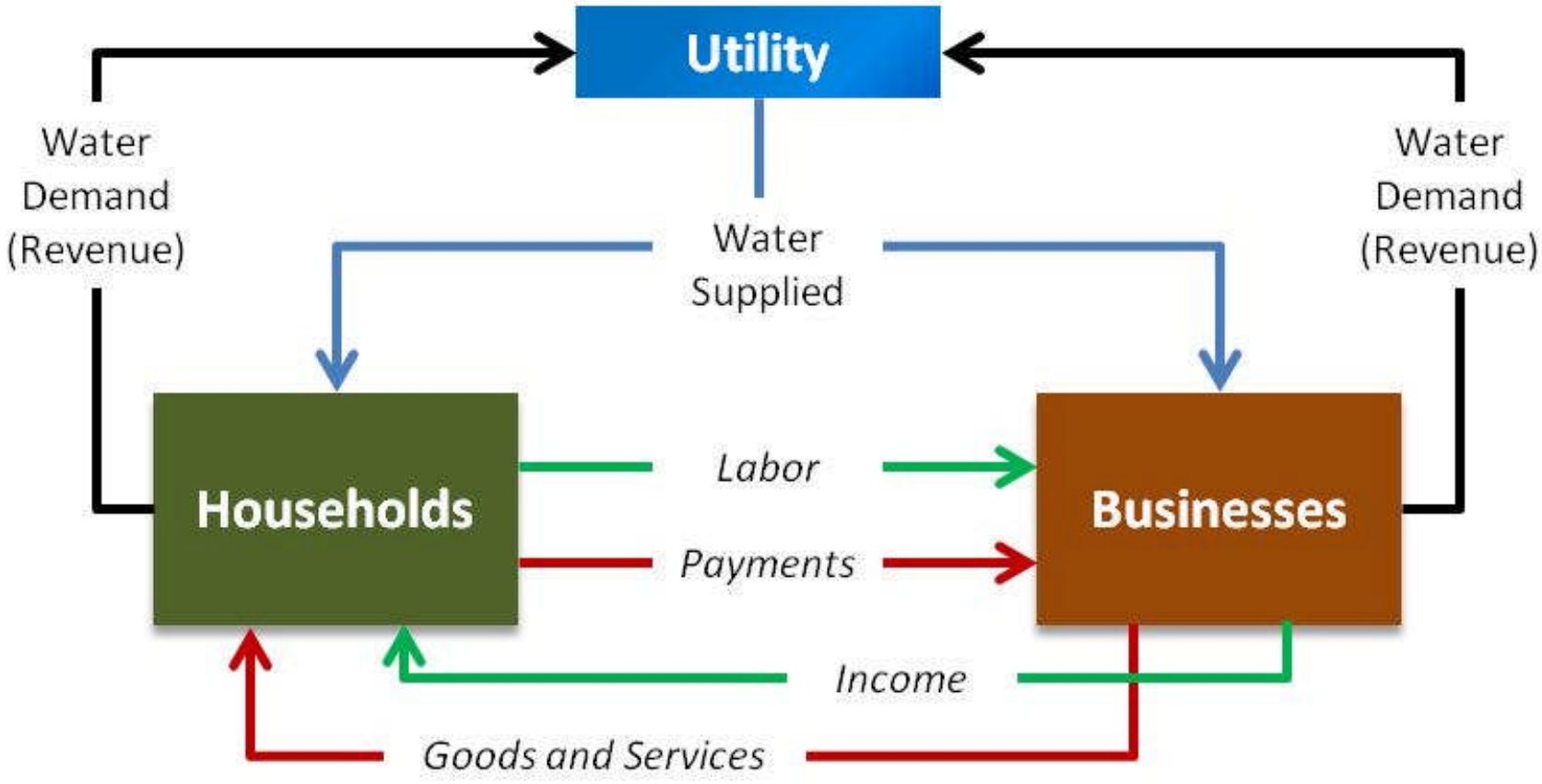
- Proper attribution of variance
  - "Collinearity"
  - Common trend
  - Signal to noise ratio
- Definition and measurement of variables
  - Time-series versus cross-sectional
  - Geographic and agent specificity
  - Suitable proxies
  - Lagged effects
- Ability to translate relationships into planning tools

WaterRF Project 4458

- Understand how the recent recession may have influenced water consumption
- Investigate whether these effects can be measured and distinguished from other factors
- Examine how economic factors might be better incorporated and used to assist in forecasting water use

- Is there a detectable signal of the recent recession in water use data, and, if so, what are the pathways of influence?

Classic Economic Context



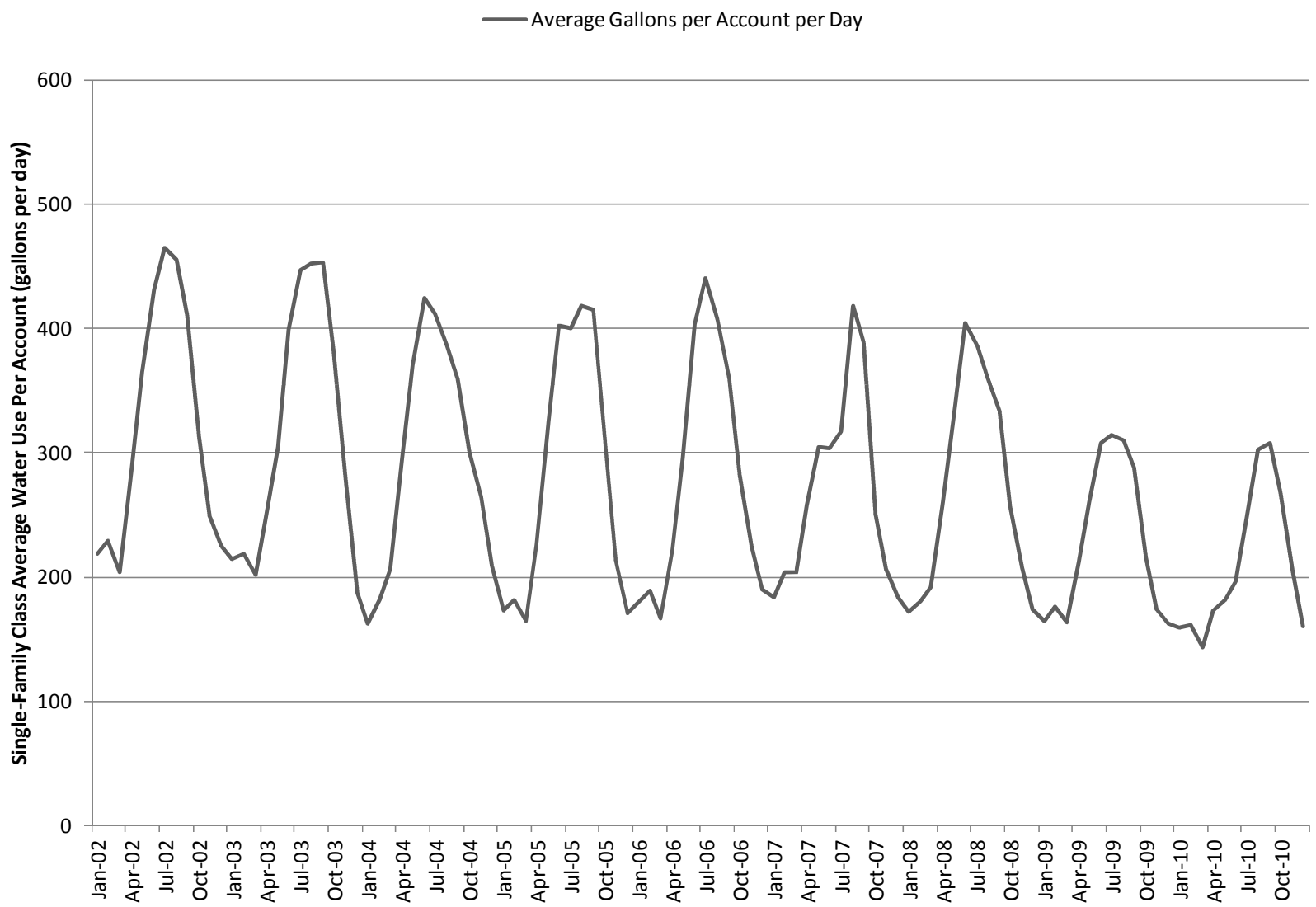
Characteristics of "Great Recession"

- Between the 3rd quarter of 2007 and 2nd quarter of 2009:
  - Real gross domestic product (GDP) declined by 5.1 percent
  - Unemployment rose from a rate of 5.1 percent to a rate of 9.5 percent ("official" rate)
  - Real (inflation-adjusted) household mean income fell by 11.1 percent; real median income fell by 7.7 percent
  - Median family net worth fell by 38.8%; mean net worth fell by 14.7 percent (asset prices drop dramatically relative to liabilities)
- "Balance sheet" or "de-leveraging" recession

Visualization of Trends

MID-SIZED UTILITY IN CALIFORNIA

Single Family Gallons per Account per Day (2002-2010)



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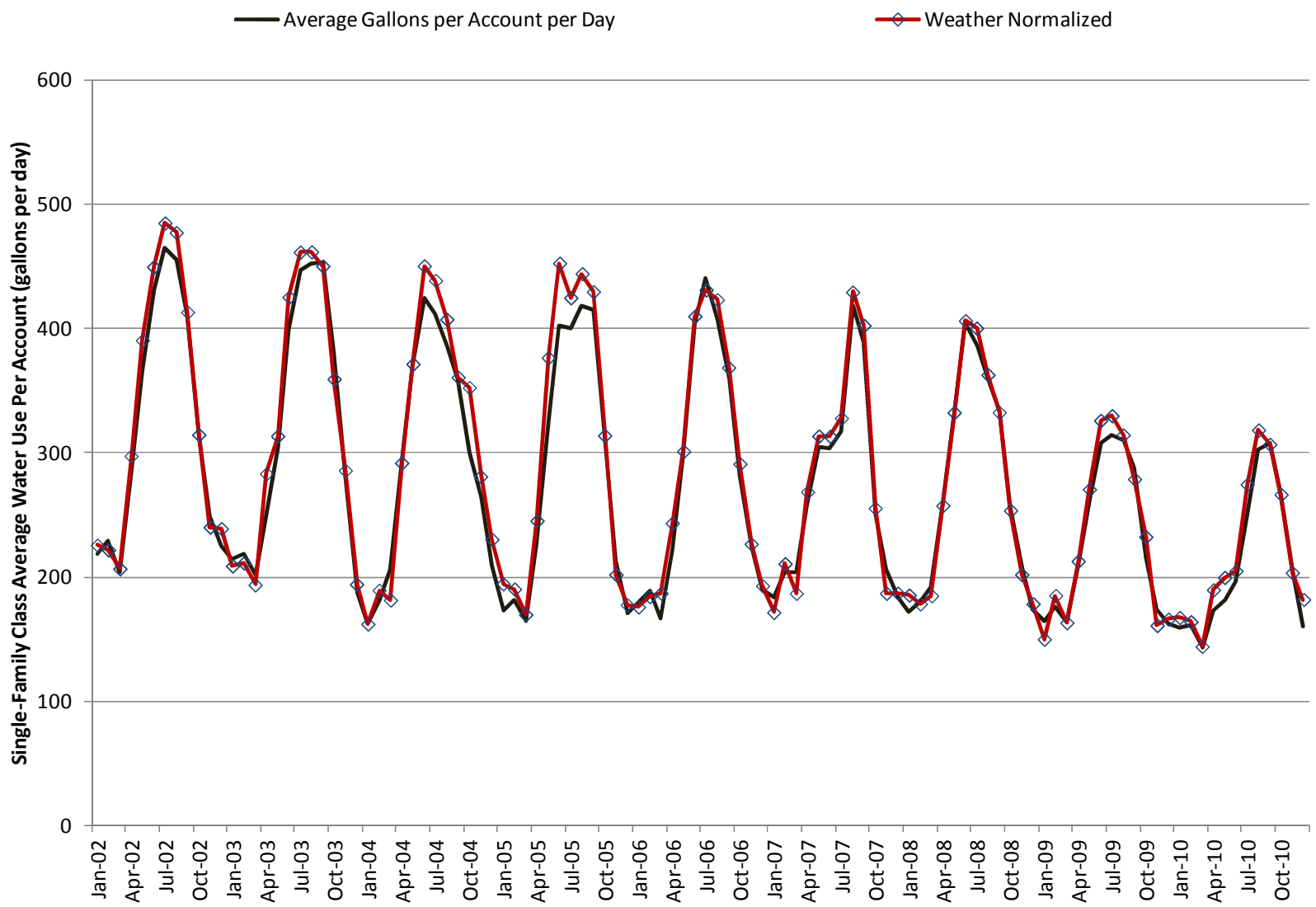

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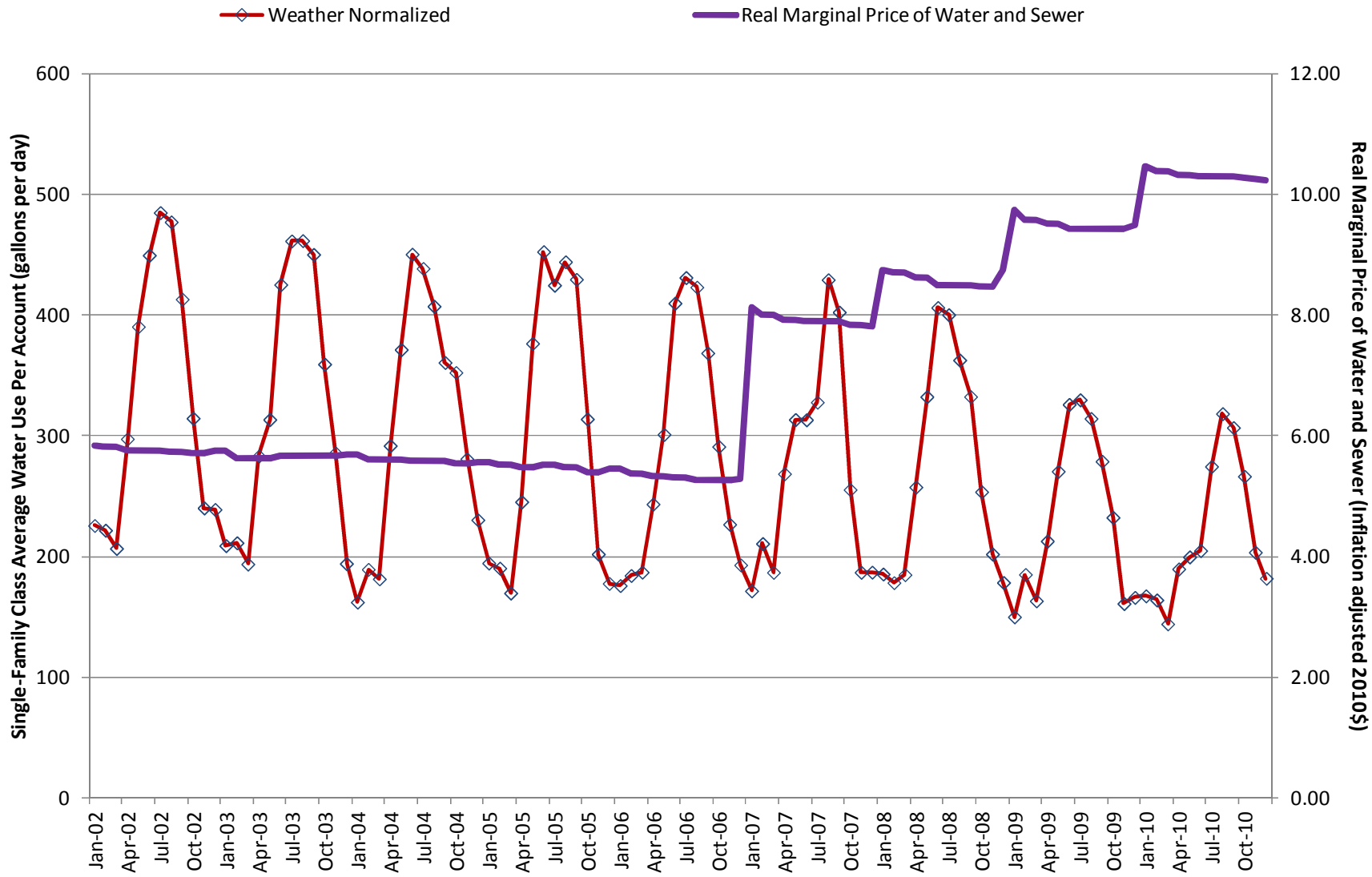

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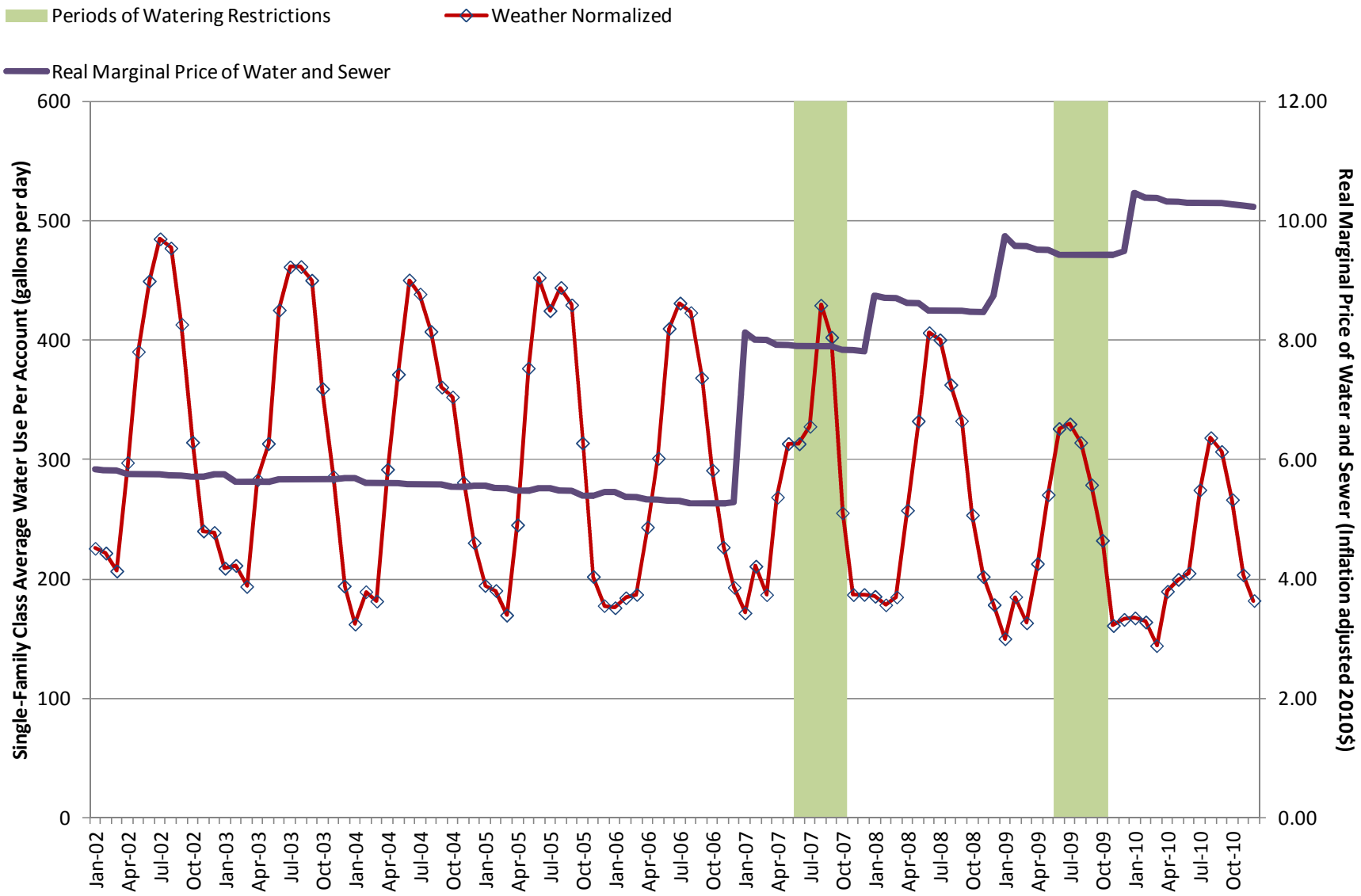

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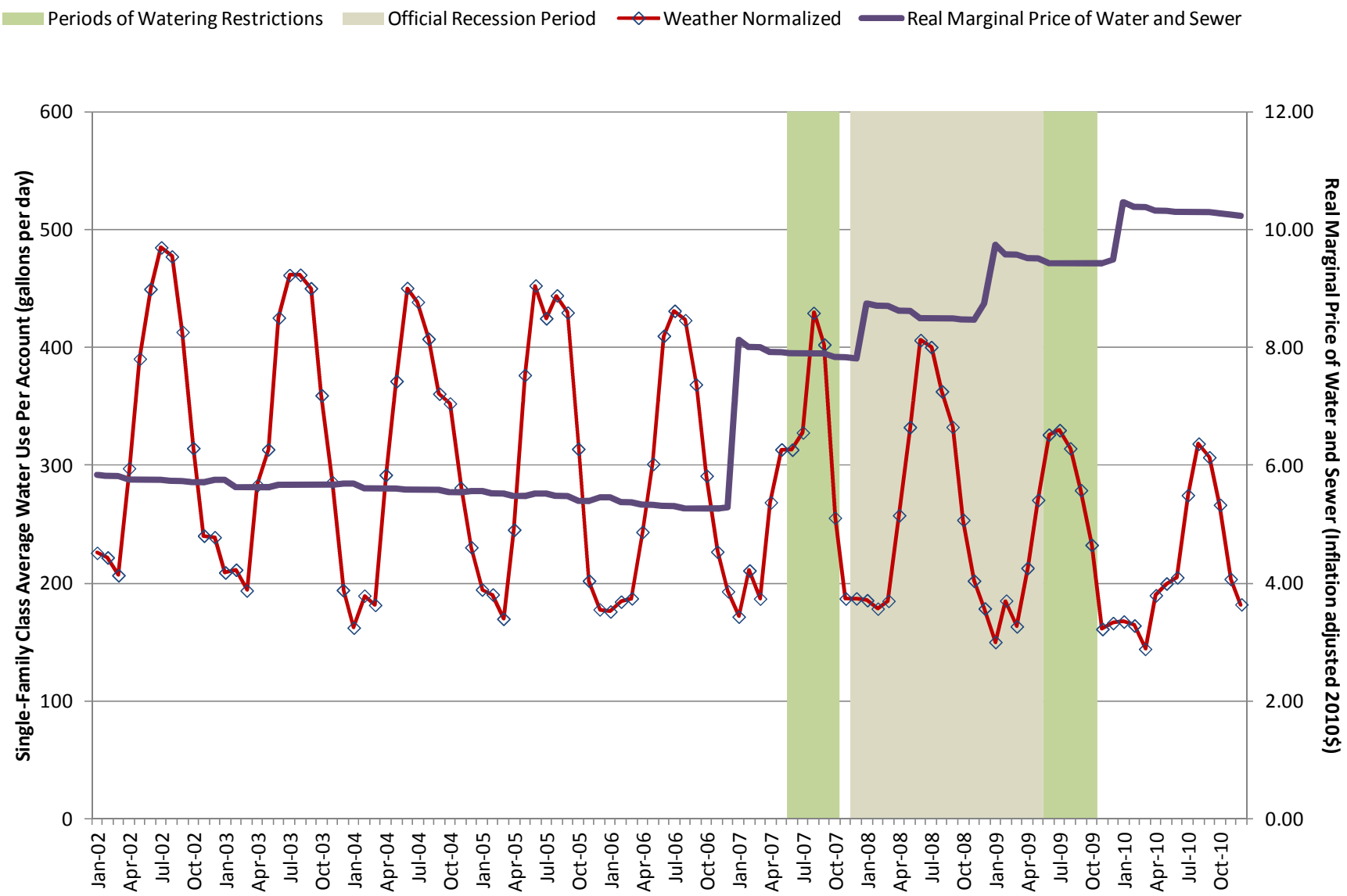

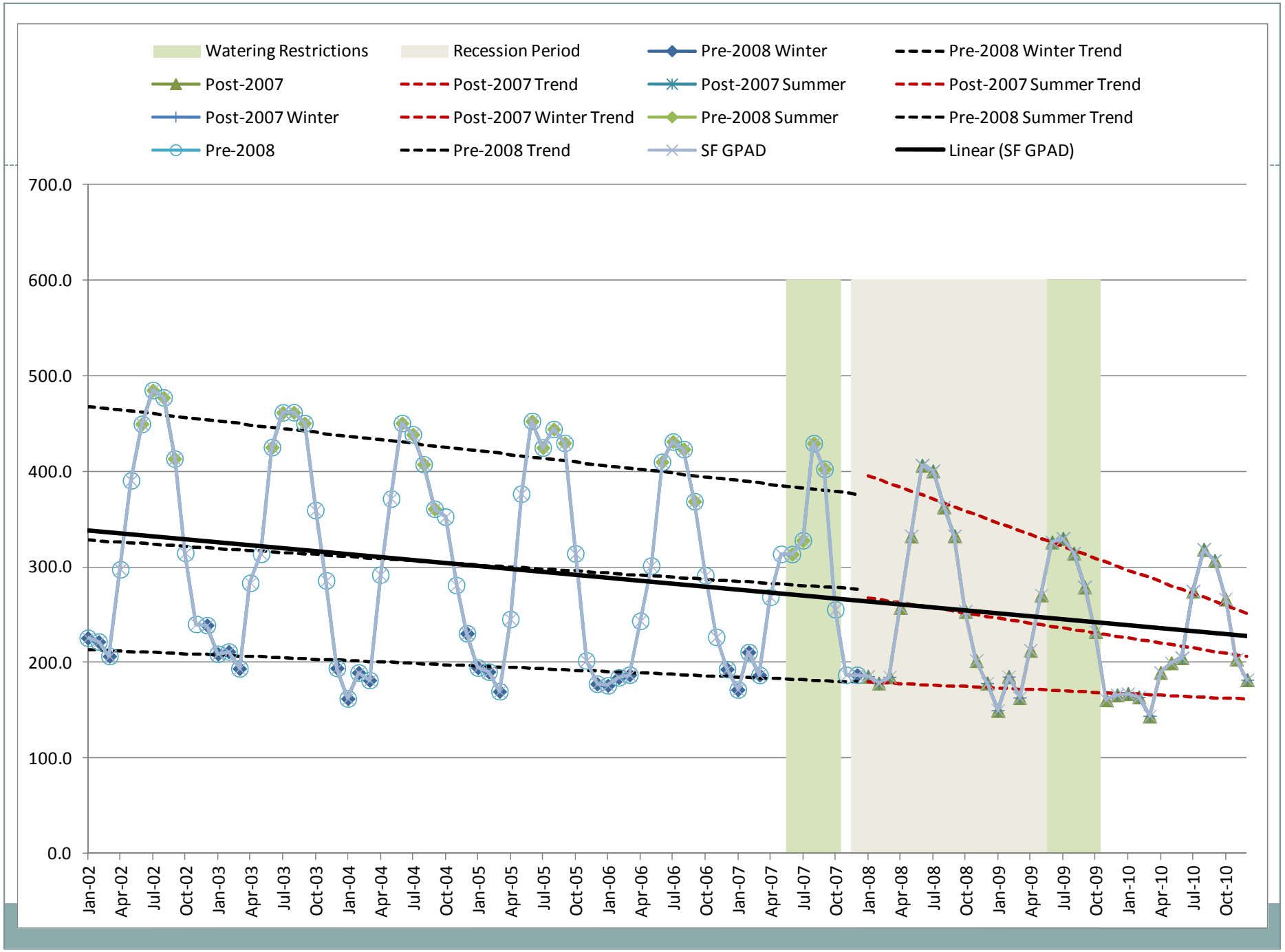
Watering Restrictions
Recession Period
Pre-2008 Winter
Pre-2008 Winter Trend
Post-2007
Post-2007 Trend
Post-2007 Summer
Post-2007 Summer Trend
Post-2007 Winter
Post-2007 Winter Trend
Pre-2008 Summer
Pre-2008 Summer Trend
Pre-2008
Pre-2008 Trend
SF GPAD
Linear (SF GPAD)
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600.0
500.0
400.0
300.0
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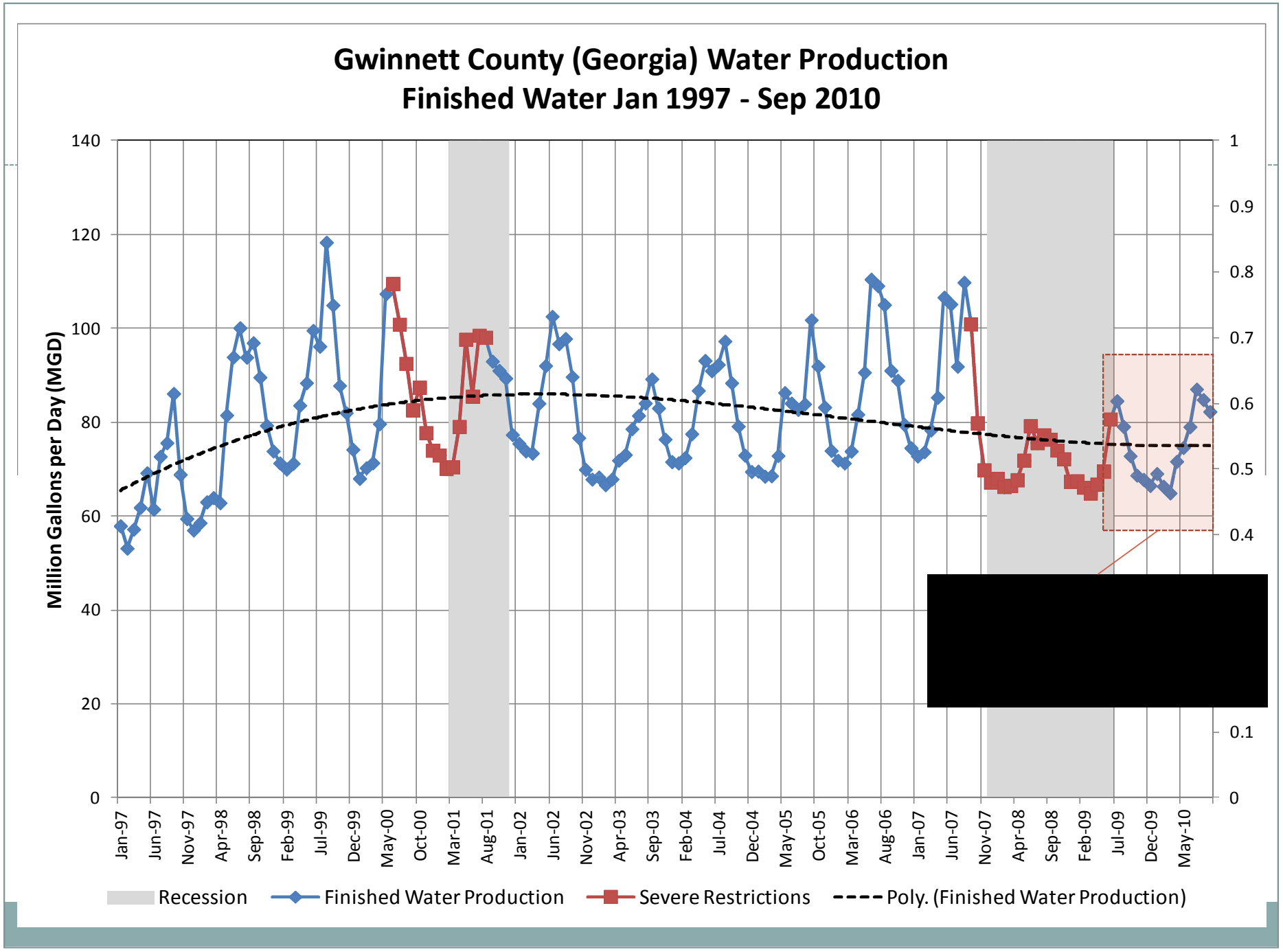
Apr-10
Jul-10
Oct-10

Visualization of Trends

GWINNETT COUNTY, GEORGIA


Gwinnett County (Georgia) Water Production
Finished Water Jan 1997 - Sep 2010
Million Gallons per Day (MGD)
140
120
100
80
60
40
20
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0.9
0.8
0.7
0.6
0.5
0.4
0.1
0
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Jun-97
Nov-97
Apr-98
Sep-98
Feb-99
Jul-99
Dec-99
May-00
Oct-00
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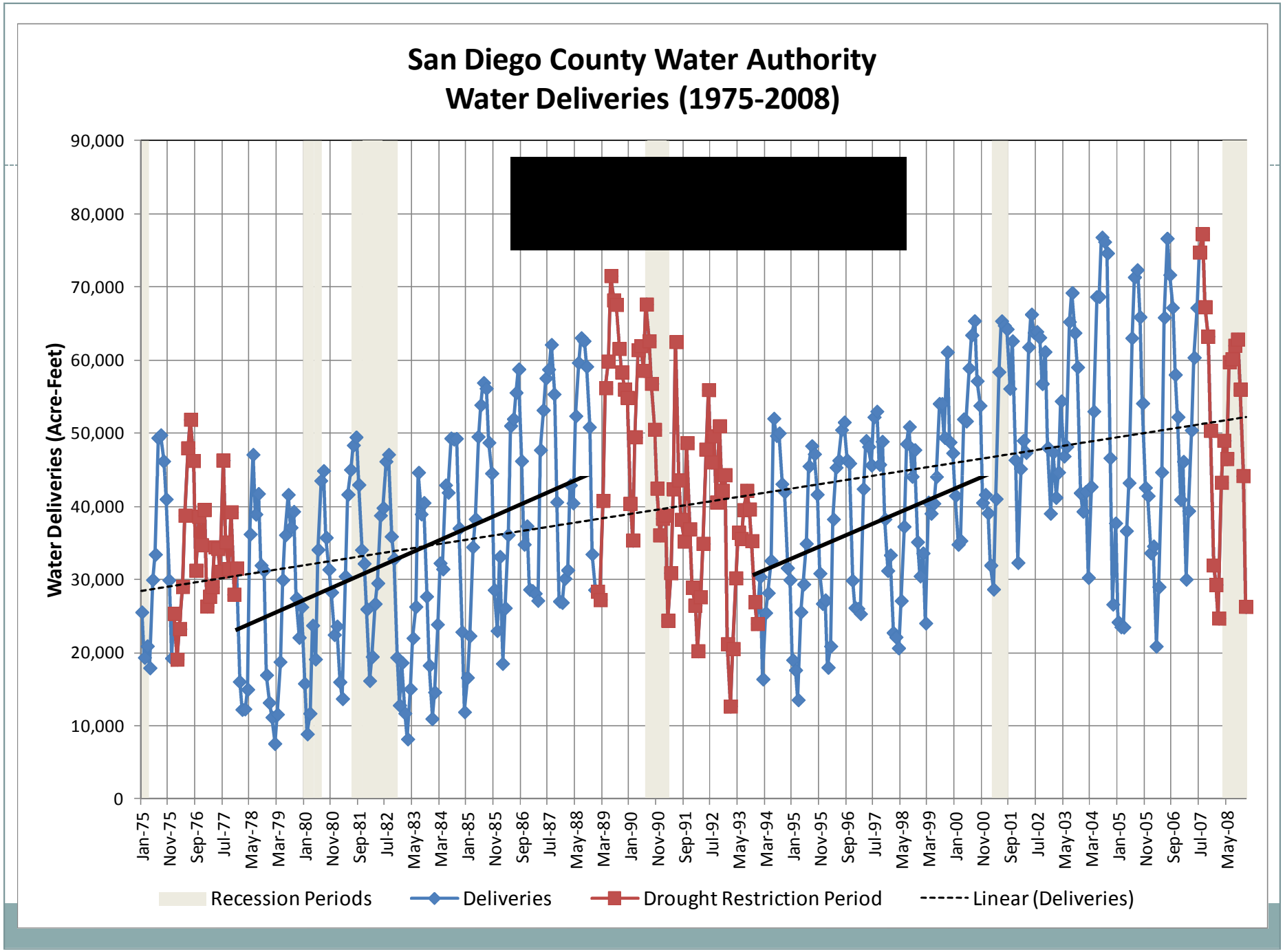
Jul-09
Dec-09
May-10
Recession
Finished Water Production
Severe Restrictions
Poly. (Finished Water Production)

Visualization of Trends

SAN DIEGO COUNTY WATER AUTHORITY


San Diego County Water Authority
Water Deliveries (1975-2008)
Water Deliveries (Acre-Feet)
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
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Nov-75
Sep-76
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May-78
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Jan-80
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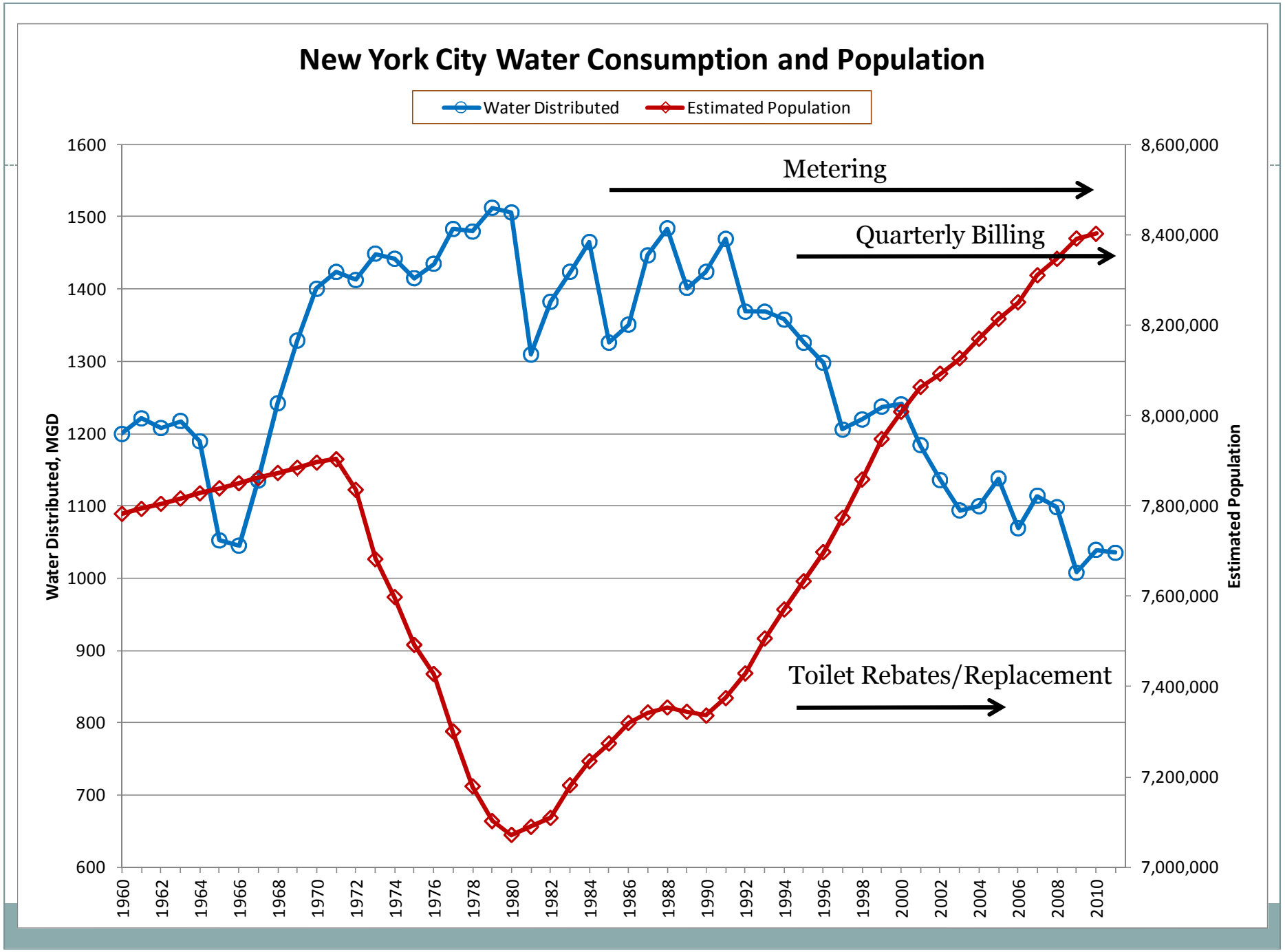
Jul-07
May-08
Recession Periods
Deliveries
Drought Restriction Period
Linear (Deliveries)

Visualization of Trends

NEW YORK CITY


New York City Water Consumption and Population
Water Distributed
Estimated Population
Metering
Quarterly Billing
Toilet Rebates/Replacement
Water Distributed, MGD
Estimated Population
1600
1500
1400
1300
1200
1100
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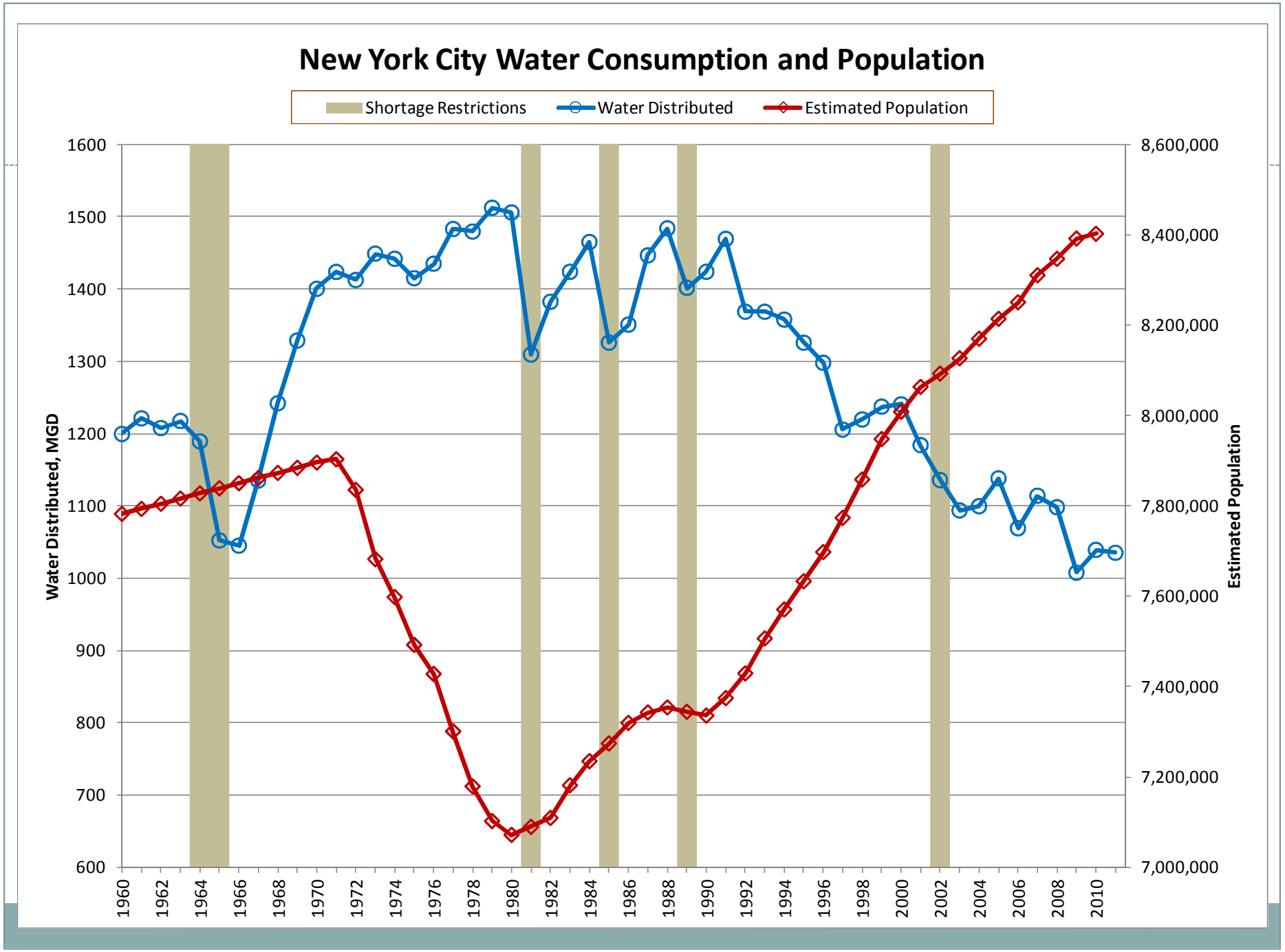
New York City Water Consumption and Population
Shortage Restrictions
Water Distributed
Estimated Population
Water Distributed, MGD
Estimated Population
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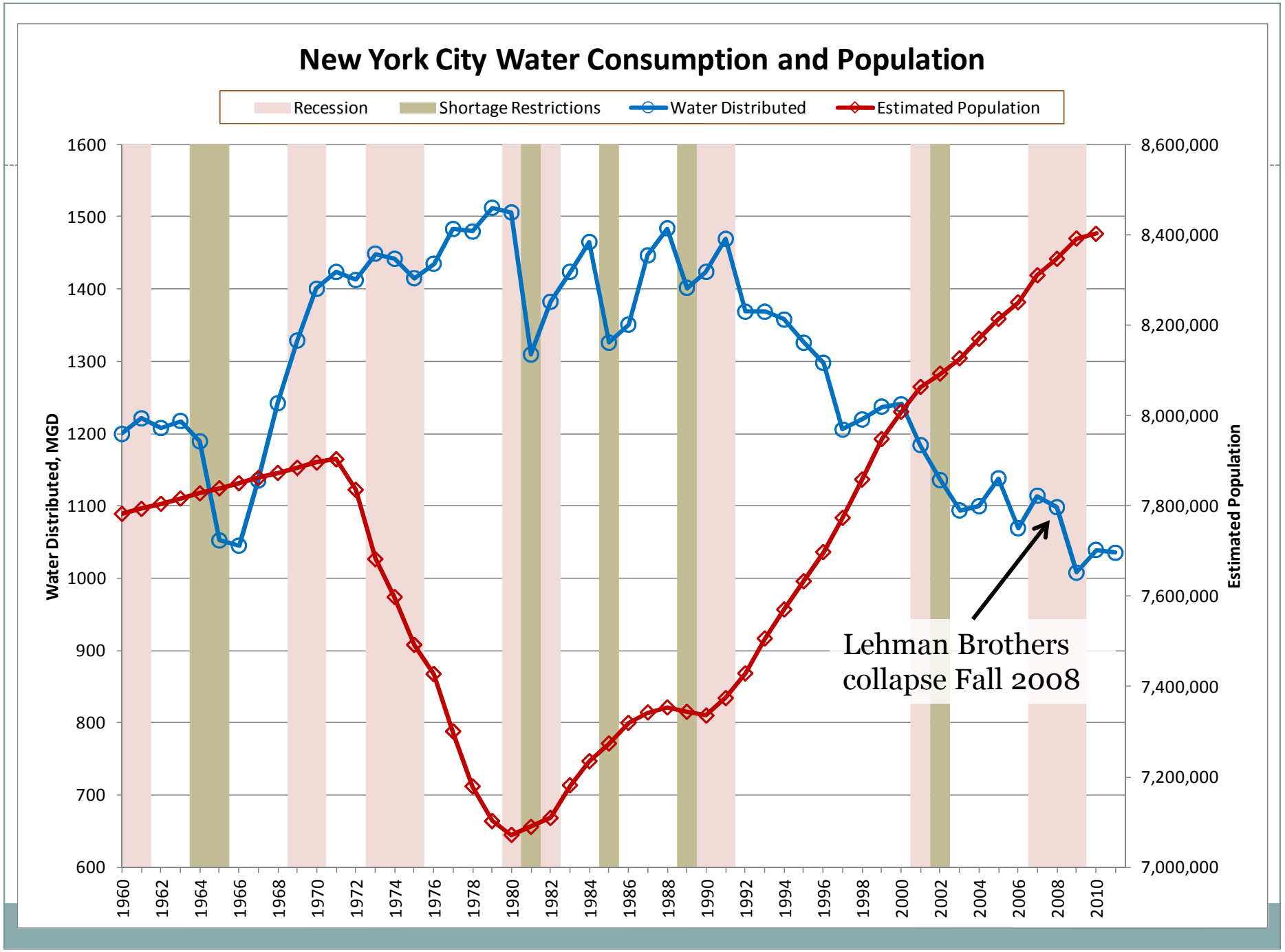
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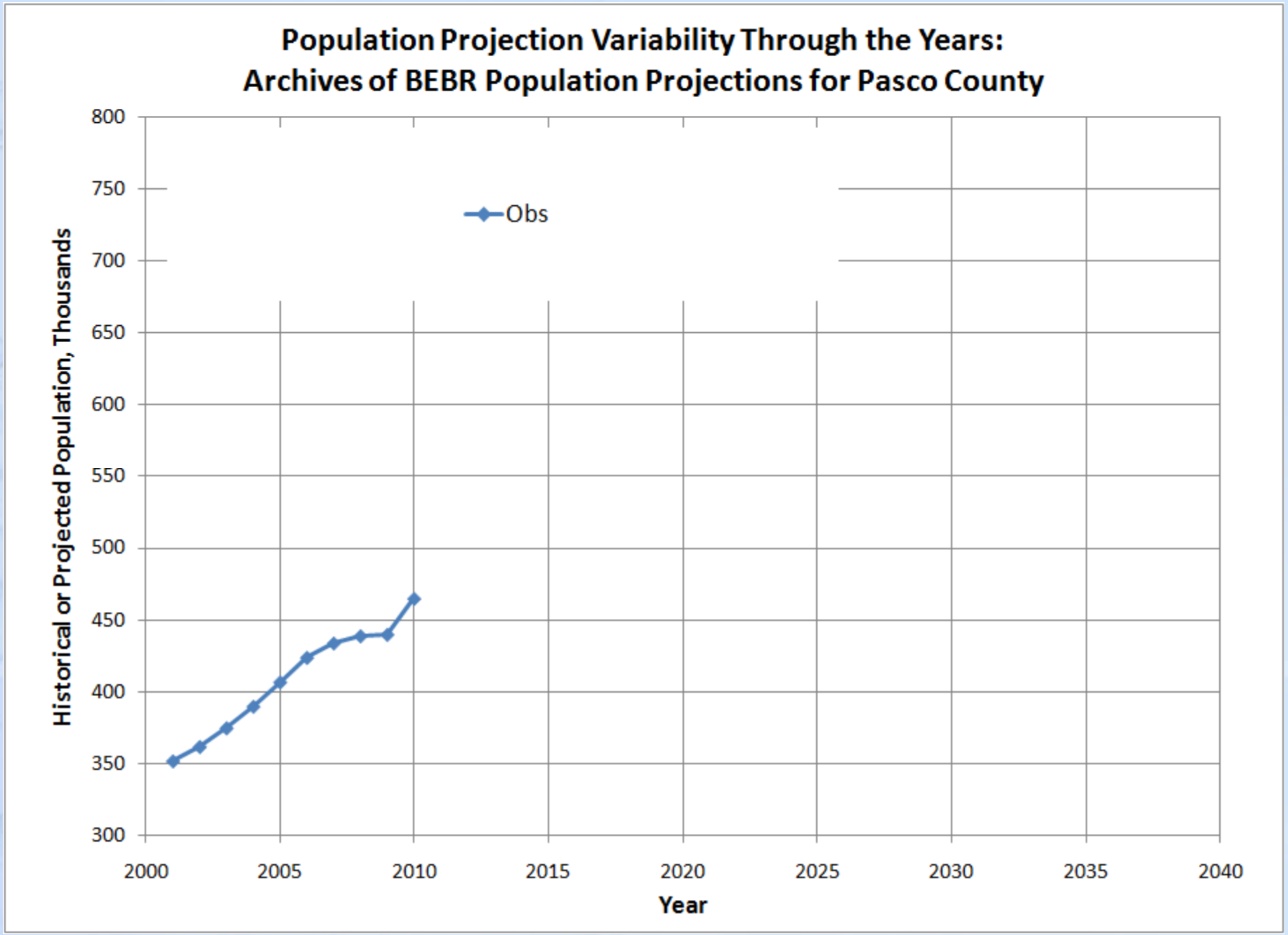
collapse Fall 2008

Economic Expectations and Forecasting

- Economic factors influence water use
- Some forecasting models incorporate economic factors
- Forecasts become conditioned on the assumed values of these economic factors
- As the economy fluctuates so do (short and long-term) expectations
  - Boom times: Economic optimism
  - Bust times: Economic pessimism

Examples of Economic Projection Volatility

- Pasco County Population Projections (BEBR)
  - "Middle" Scenarios
  - Projections produced each year from 2001-2010
  - Projections of housing and employment usually closely tied
- Tampa/St Pete/Clearwater MSA Mean Household Income Projections (Moody's)
  - Purchased periodically since 2008
  - Inflation-adjusted


Population Projection Variability Through the Years:
Archives of BEBR Population Projections for Pasco County
Historical or Projected Population, Thousands
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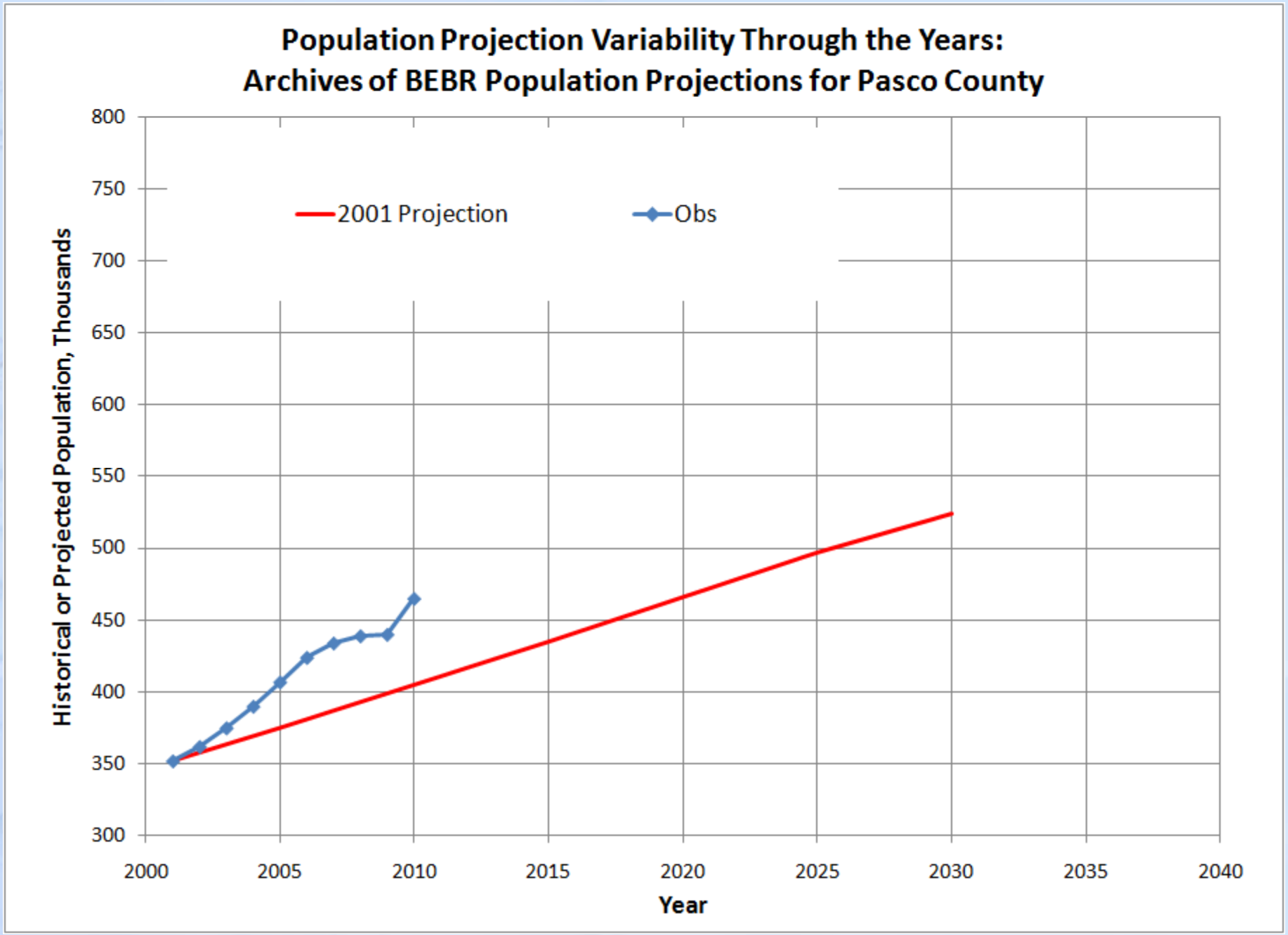
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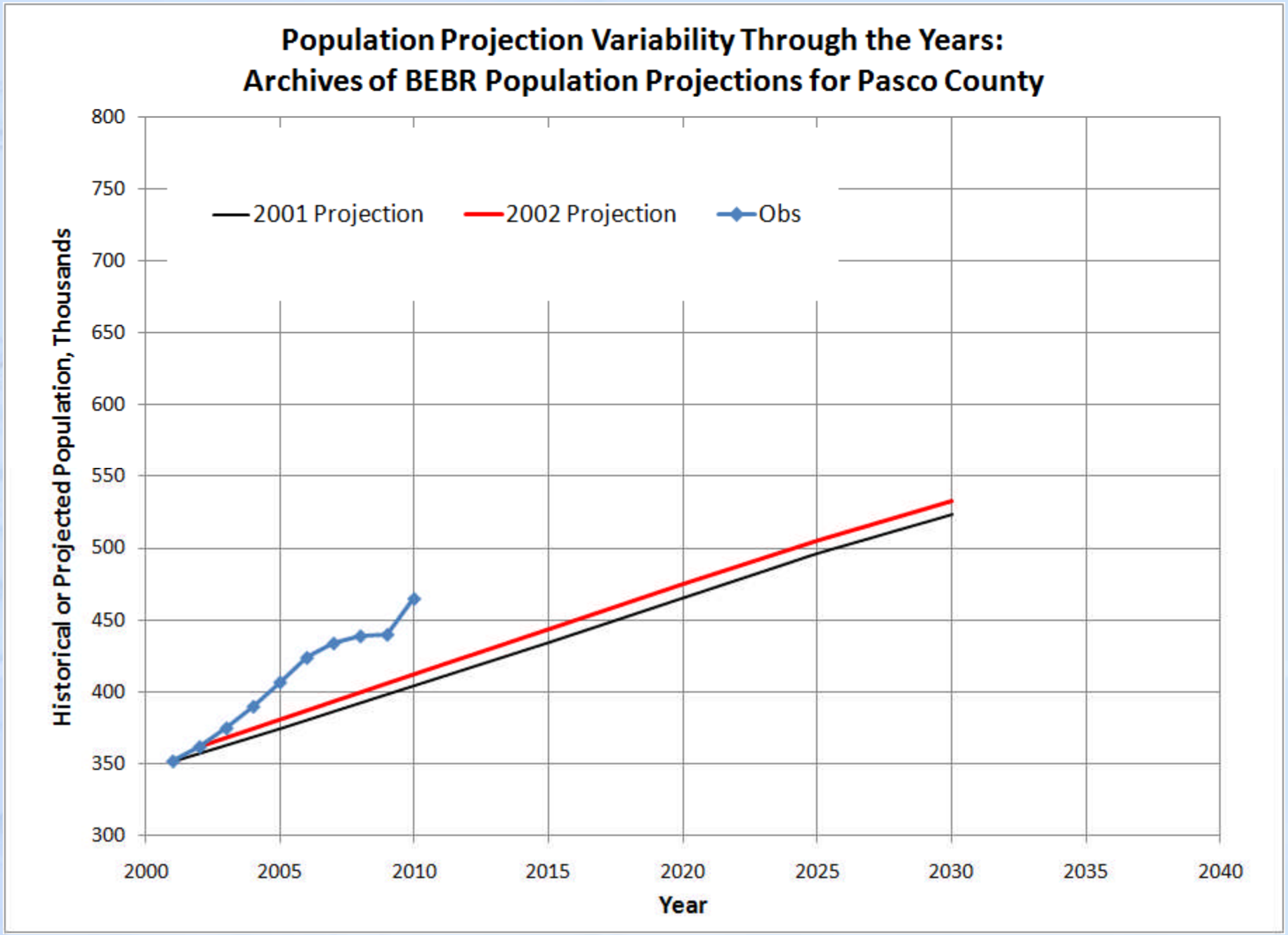
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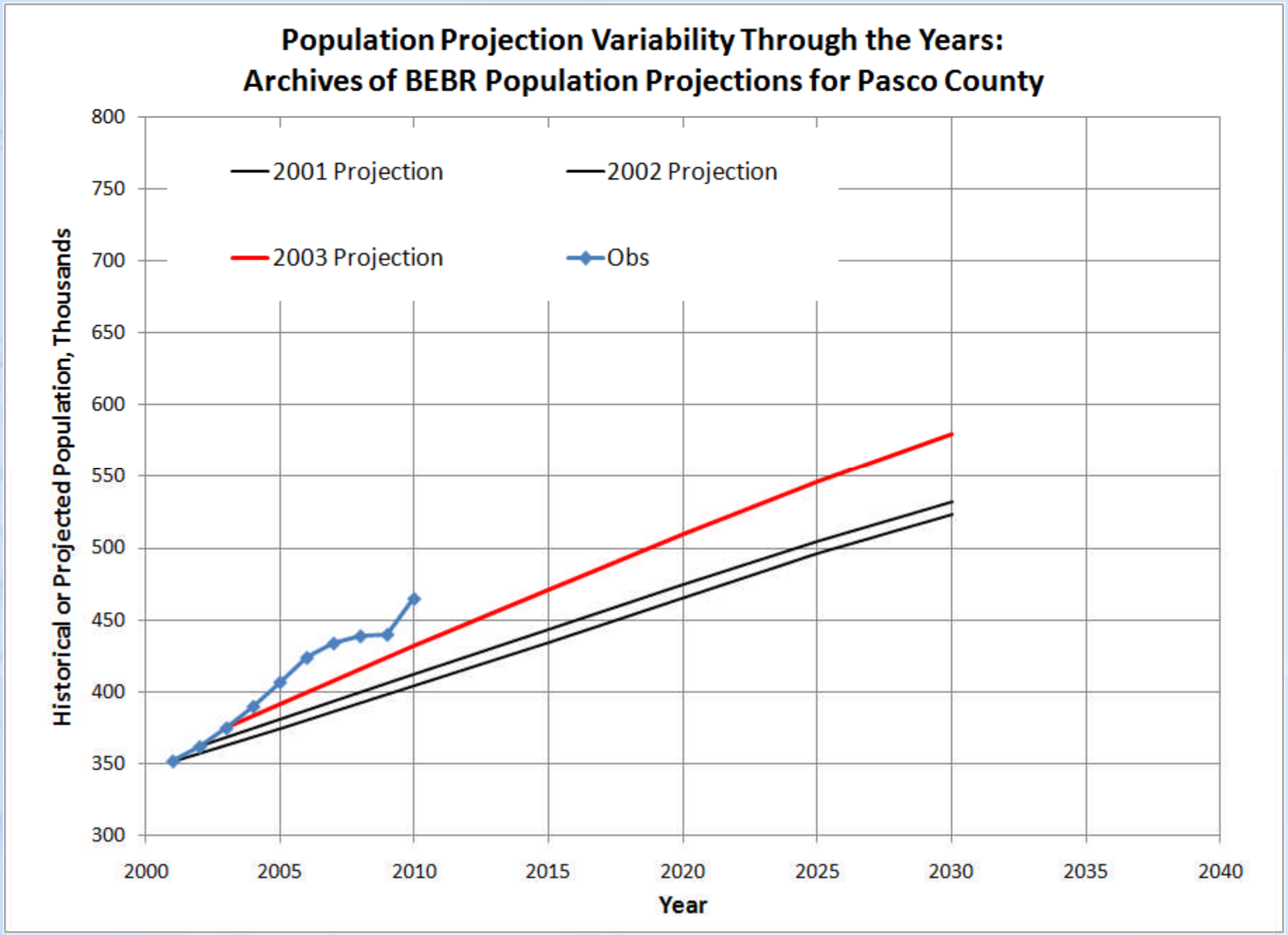
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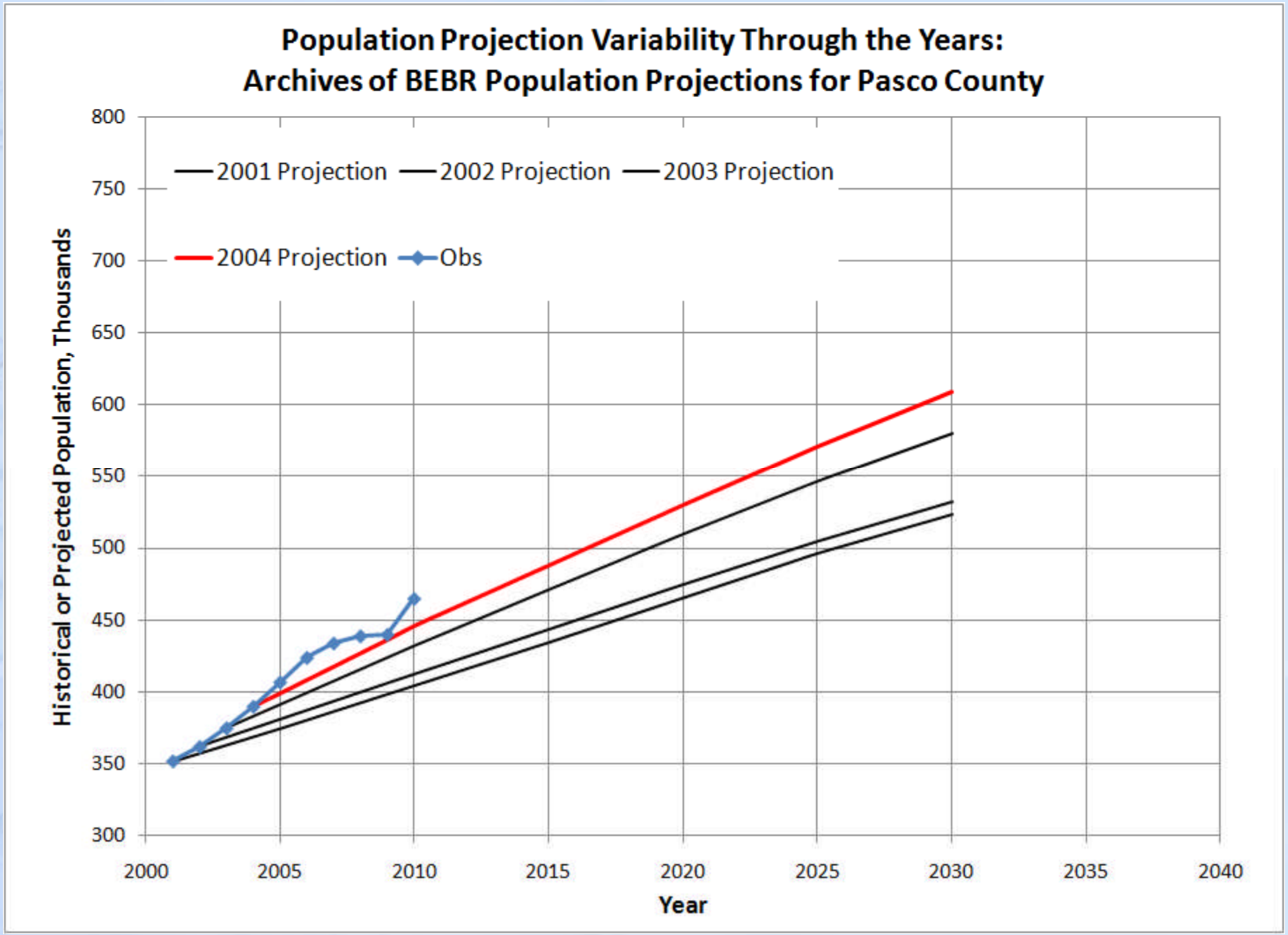
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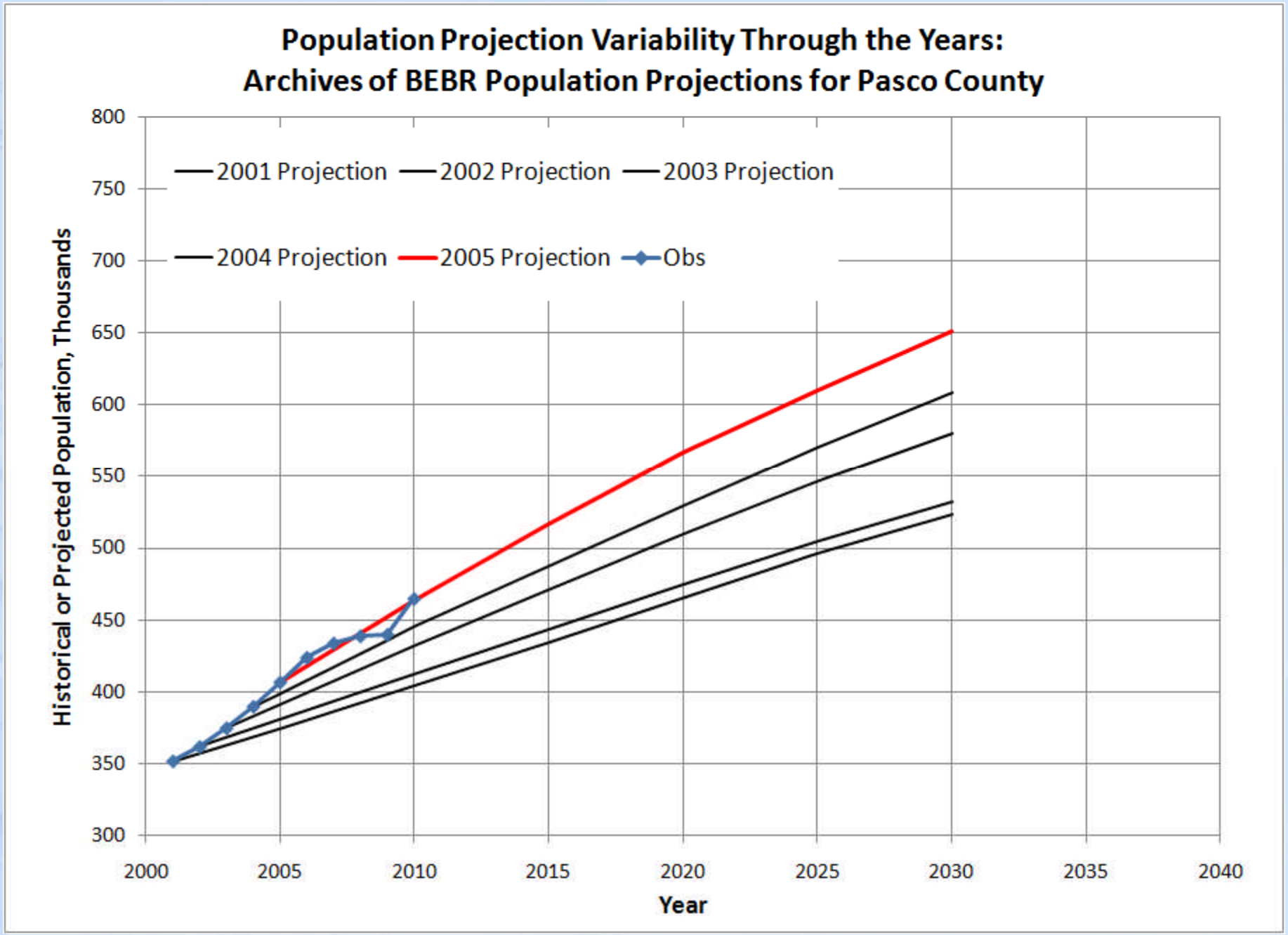
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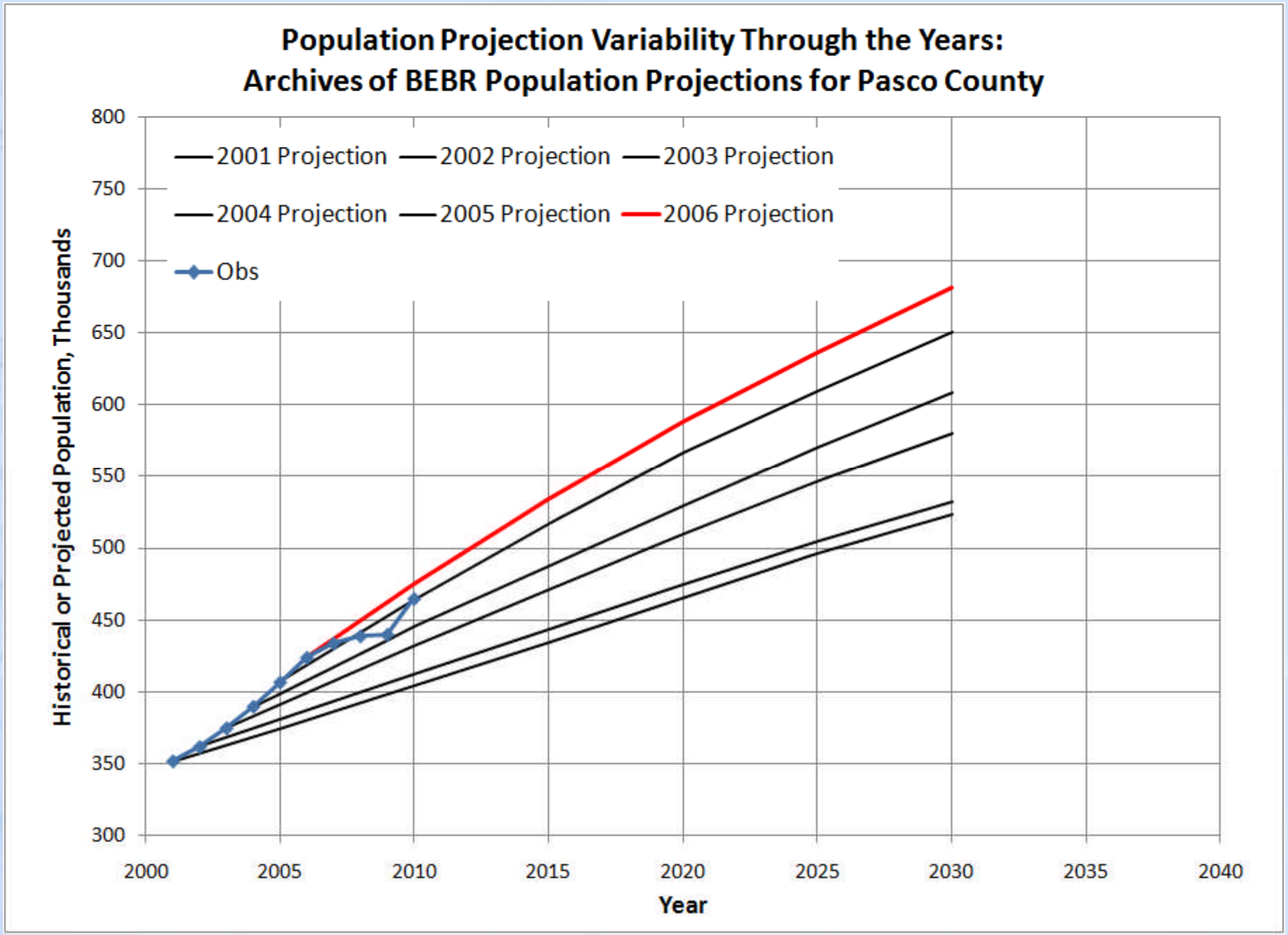
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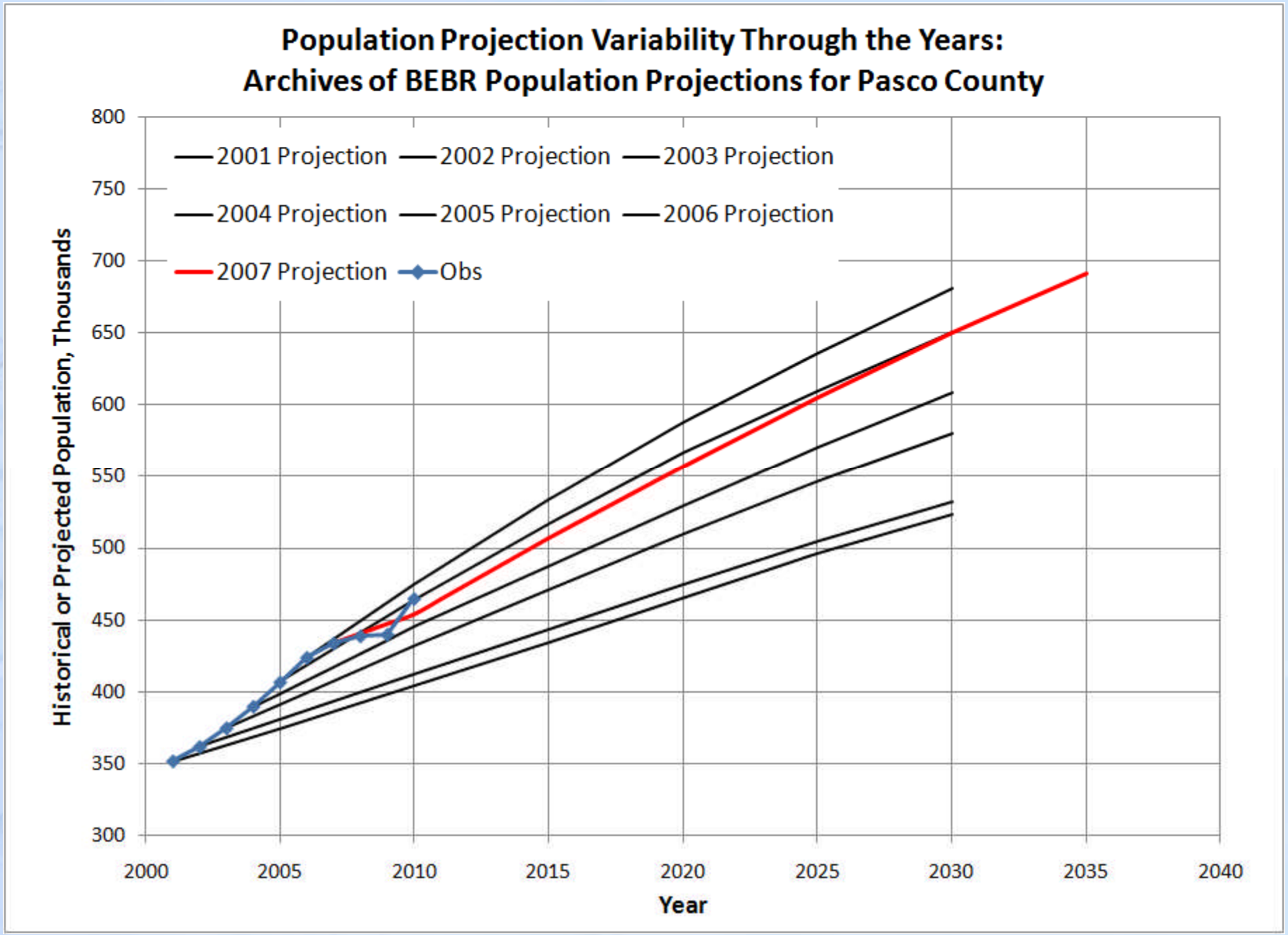
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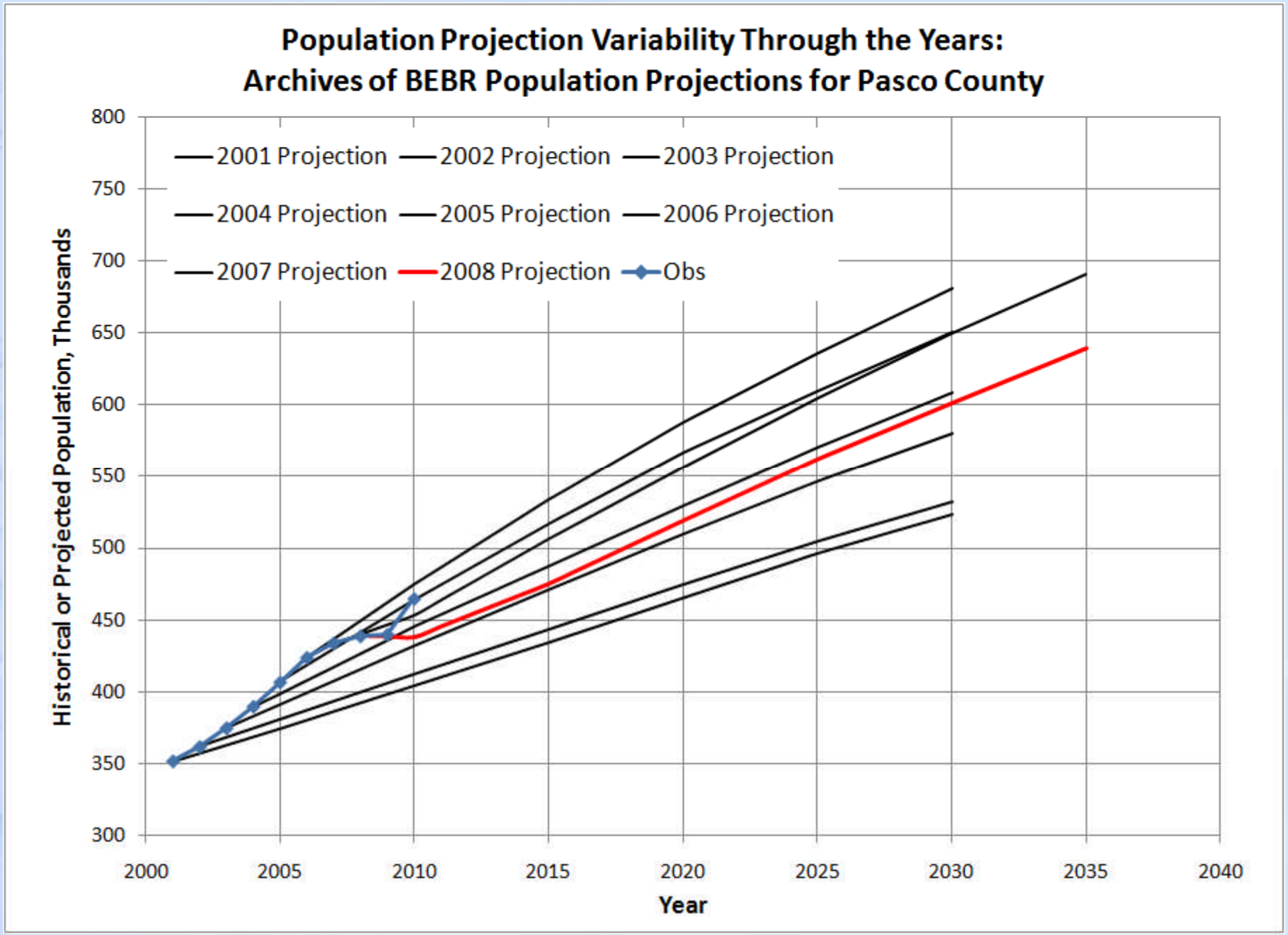
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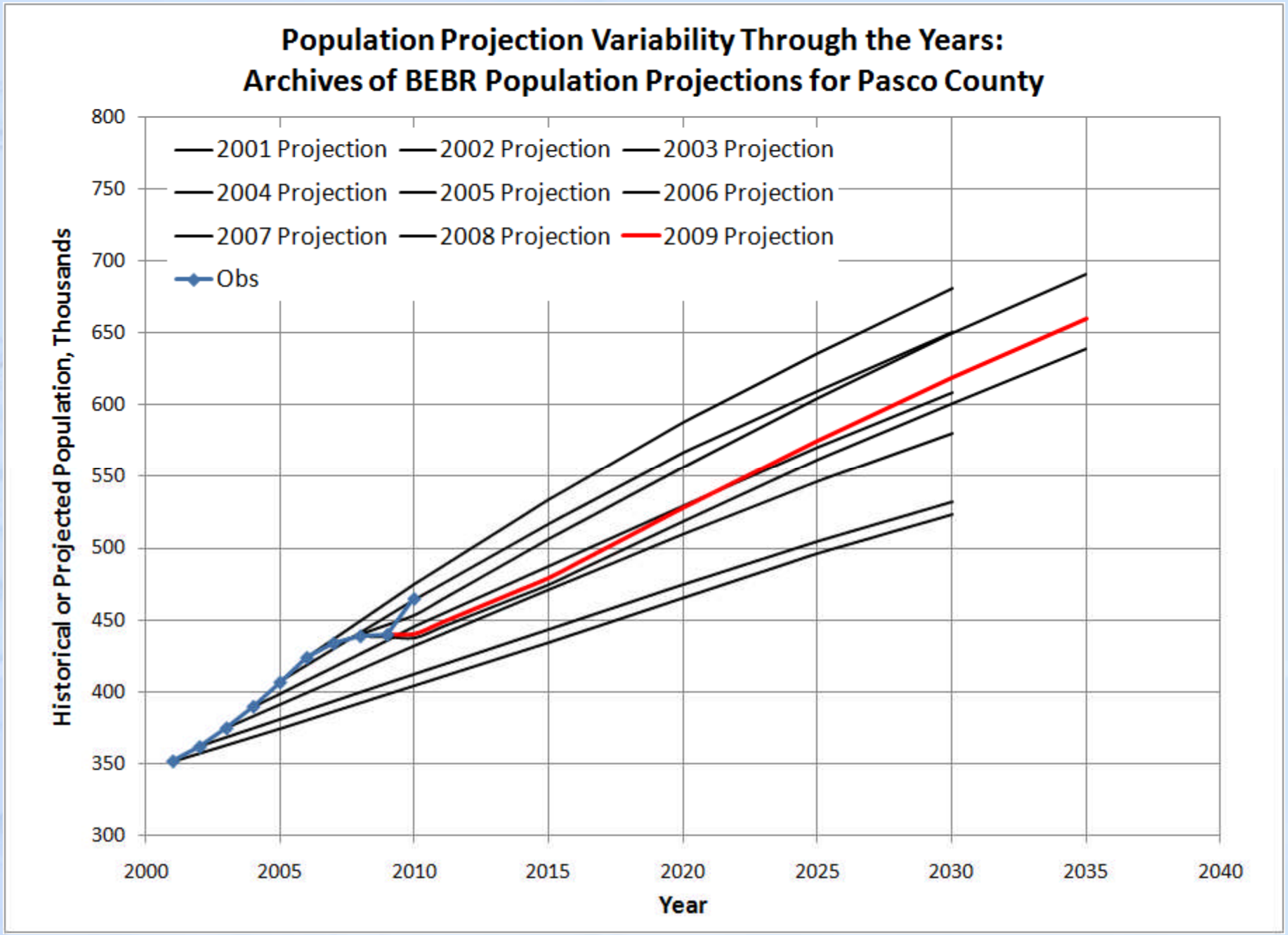
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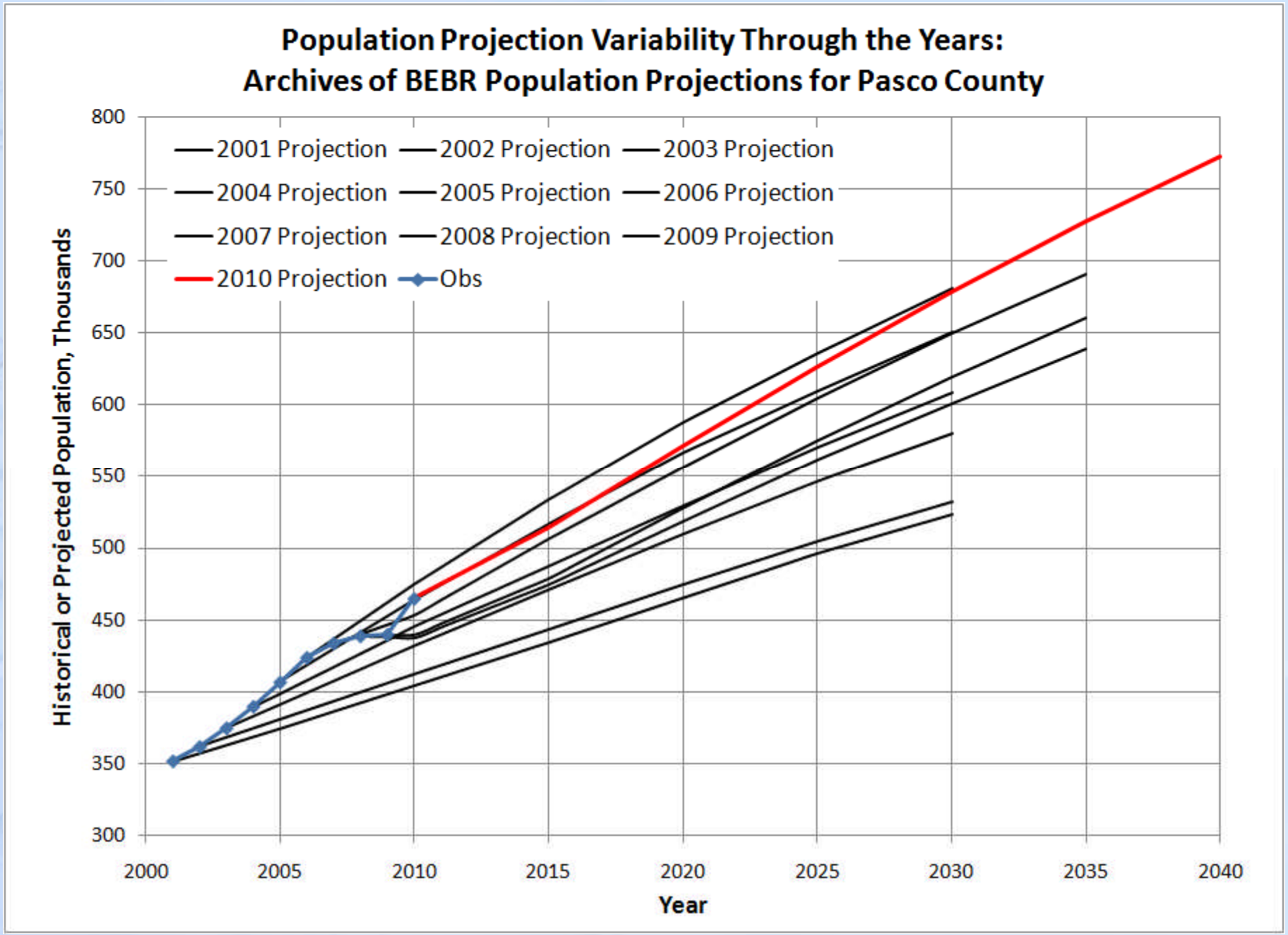
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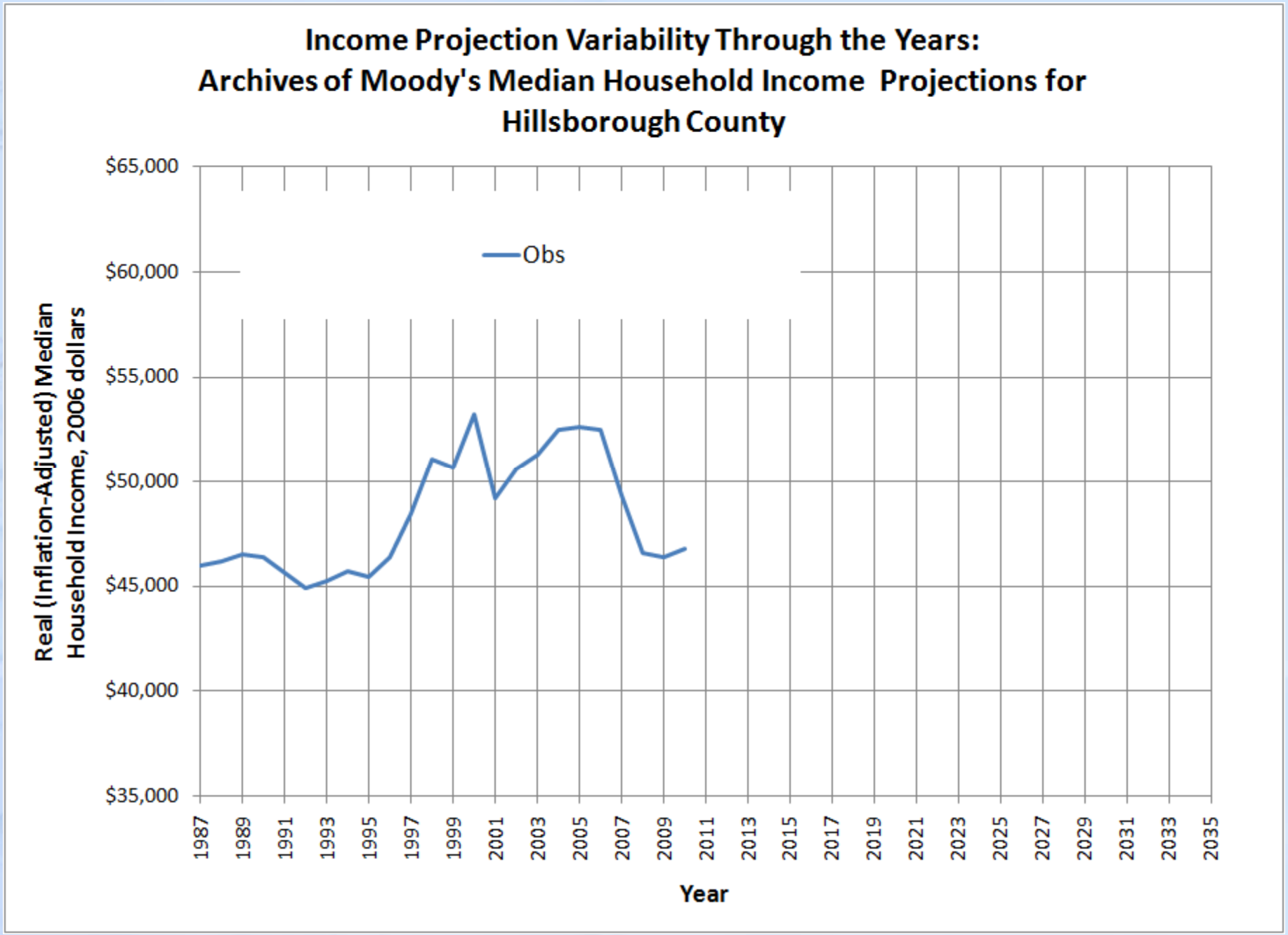
Income Projection Variability Through the Years:
Archives of Moody's Median Household Income Projections for
Hillsborough County
Real (Inflation-Adjusted) Median Household Income, 2006 dollars
$65,000
$60,000
$55,000
$50,000
$45,000
$40,000
$35,000
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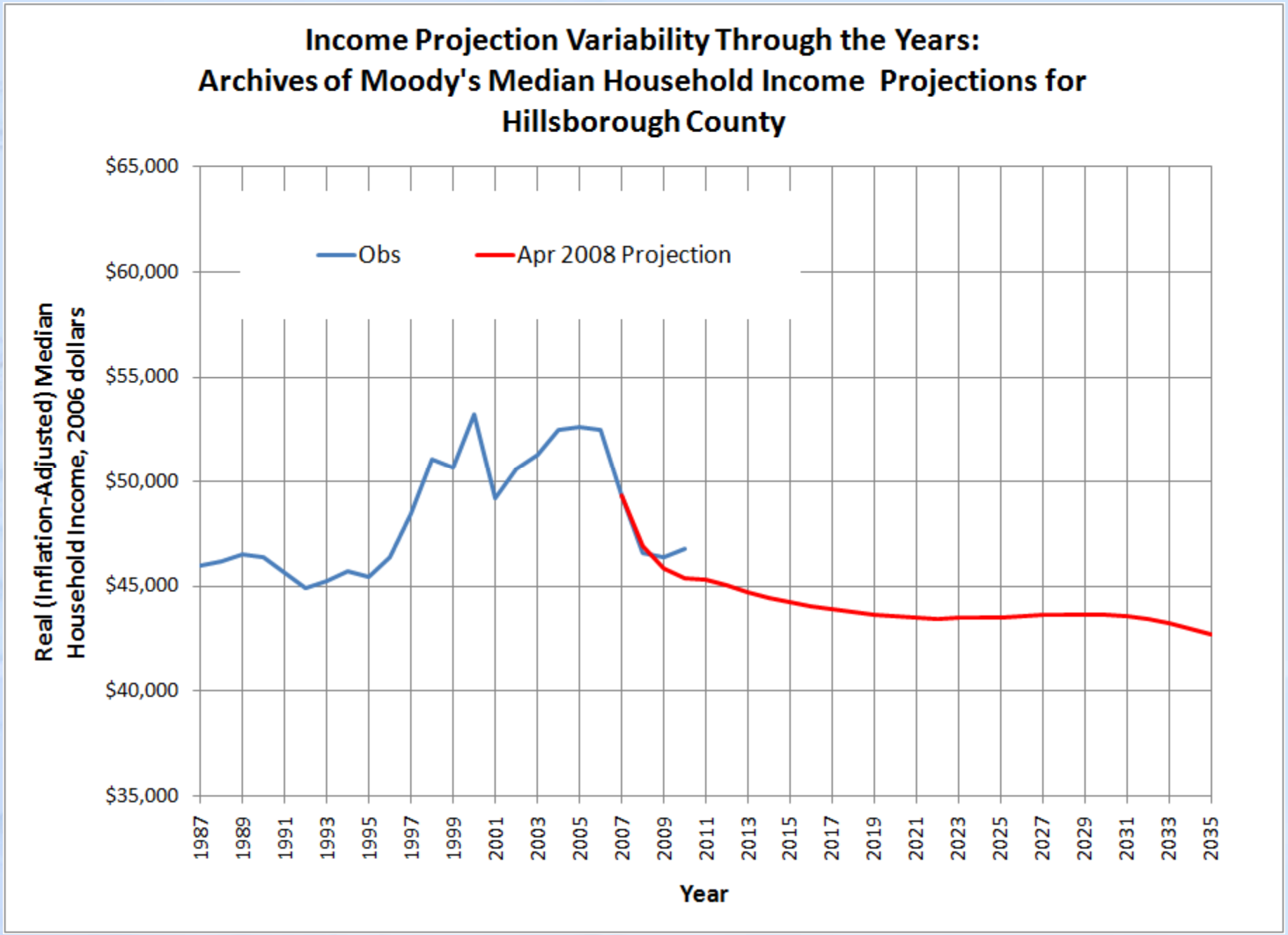
Income Projection Variability Through the Years:
Archives of Moody's Median Household Income Projections for
Hillsborough County
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Apr 2008 Projection
Real (Inflation-Adjusted) Median Household Income, 2006 dollars
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$50,000
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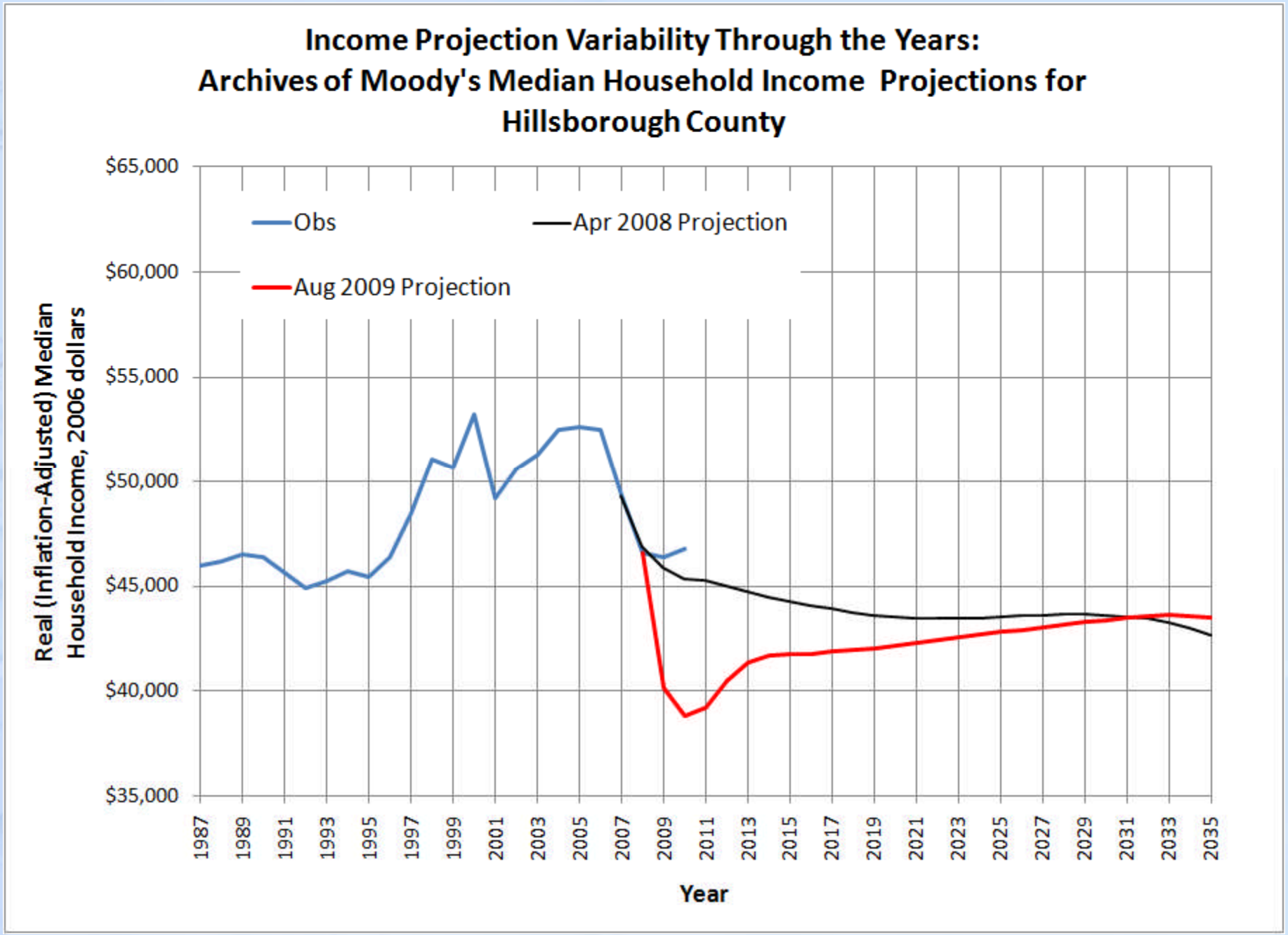
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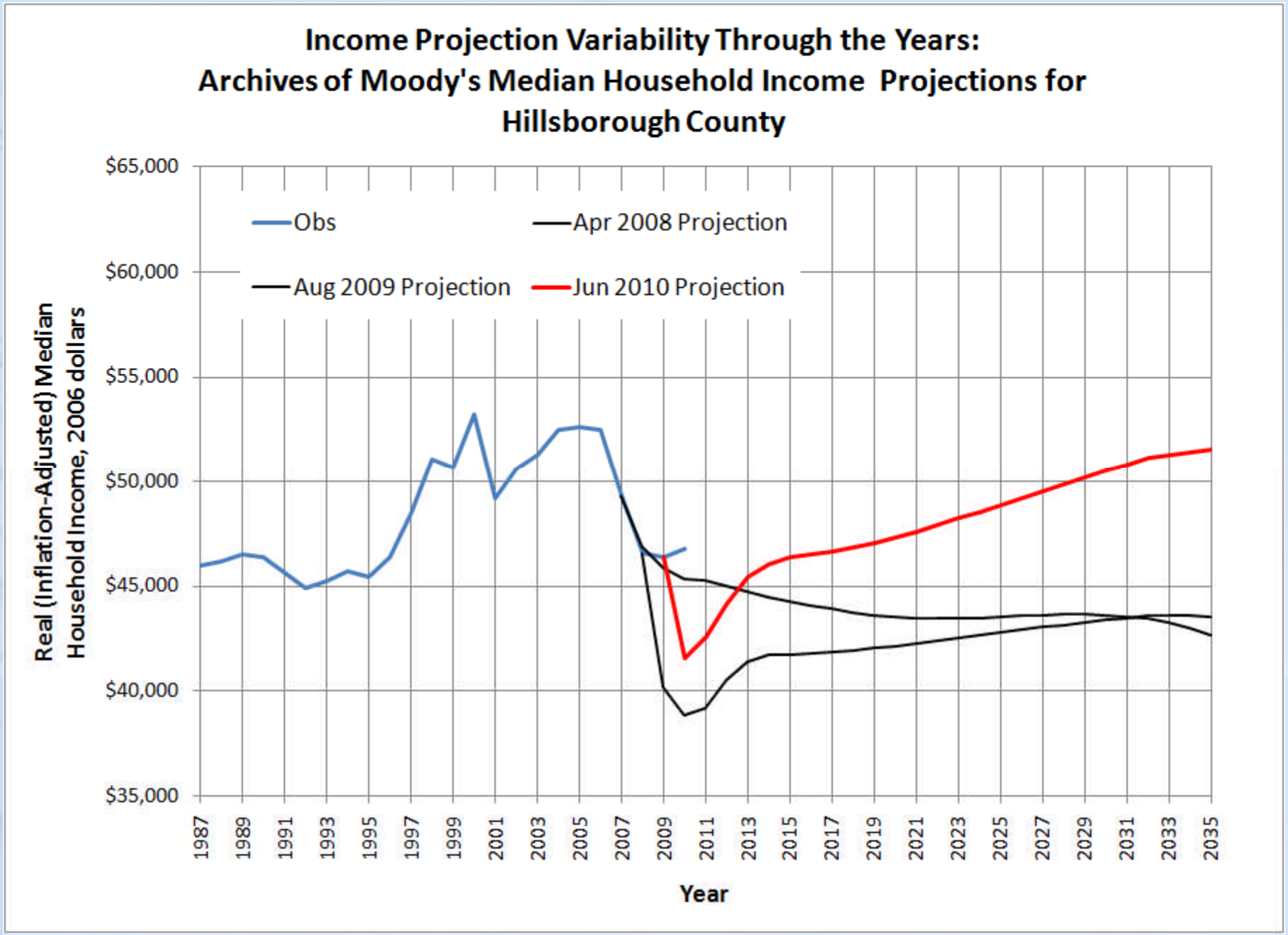
Income Projection Variability Through the Years:
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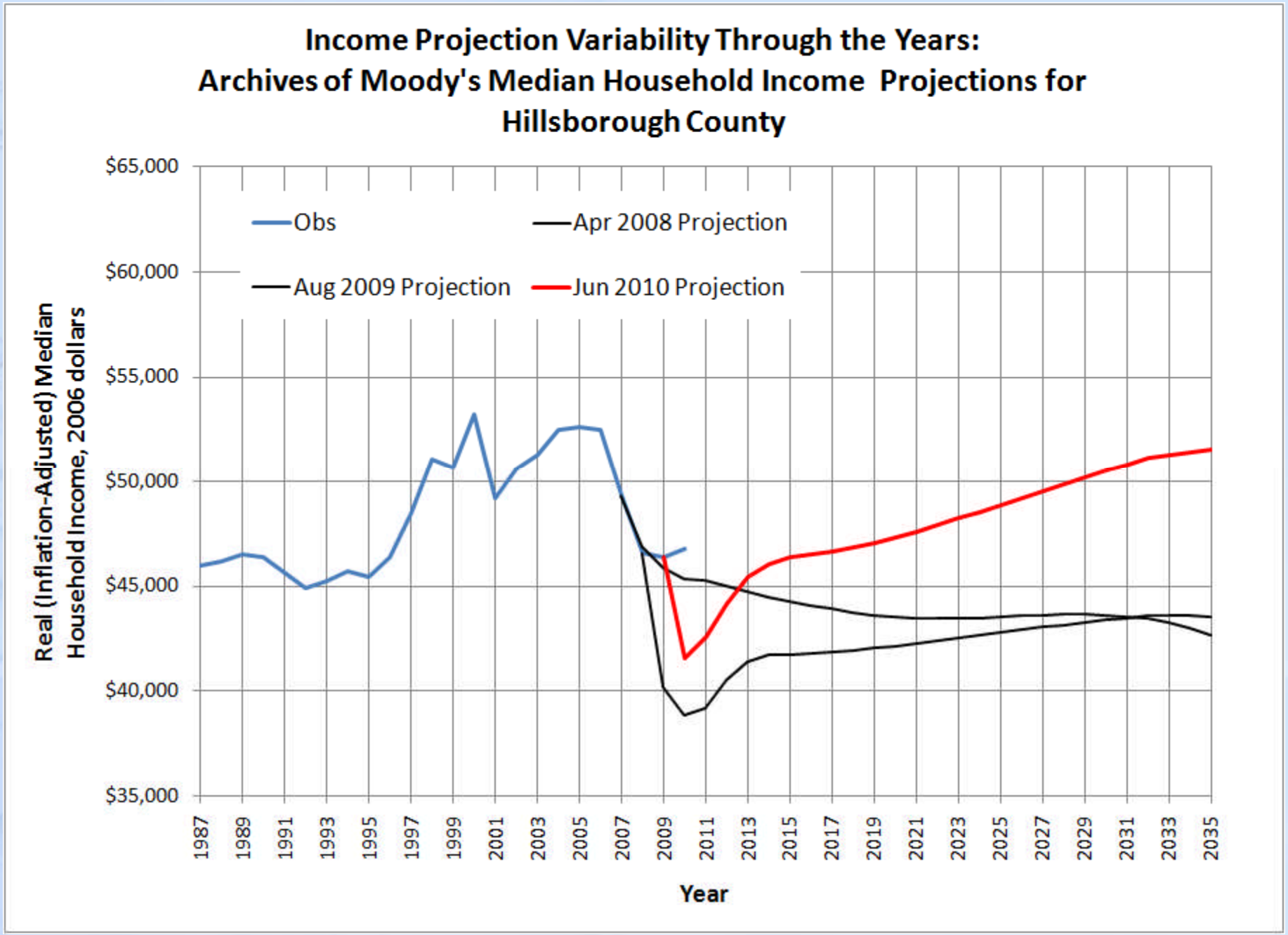
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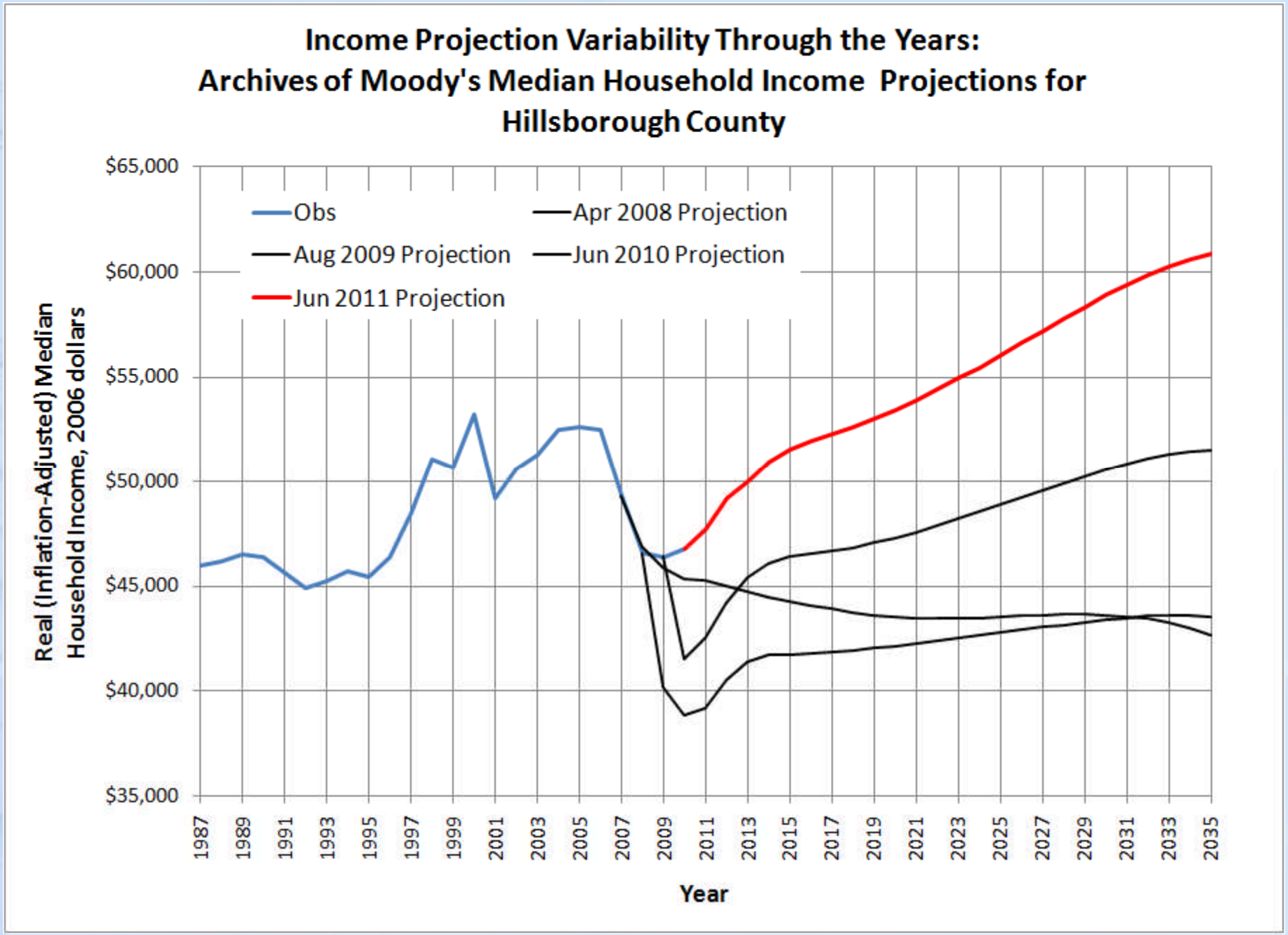
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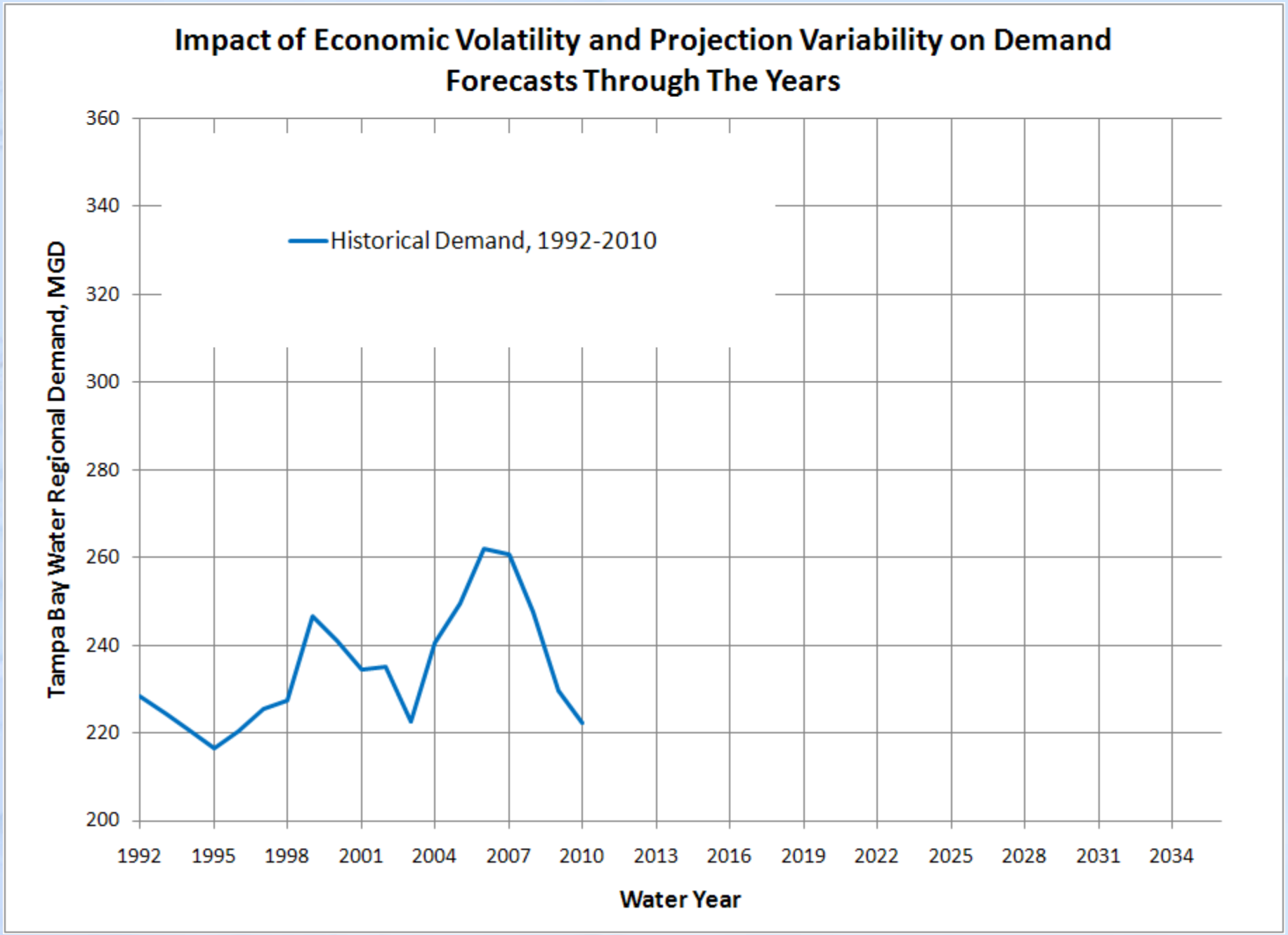
Demand Forecasting (and Forecast Accuracy) Challenging During Volatile Periods

- Frequently changing inputs
- Frequently changing outputs
- Explaining the past and adapting expectations


Impact of Economic Volatility and Projection Variability on Demand Forecasts Through The Years
Historical Demand, 1992-2010
Tampa Bay Water Regional Demand, MGD
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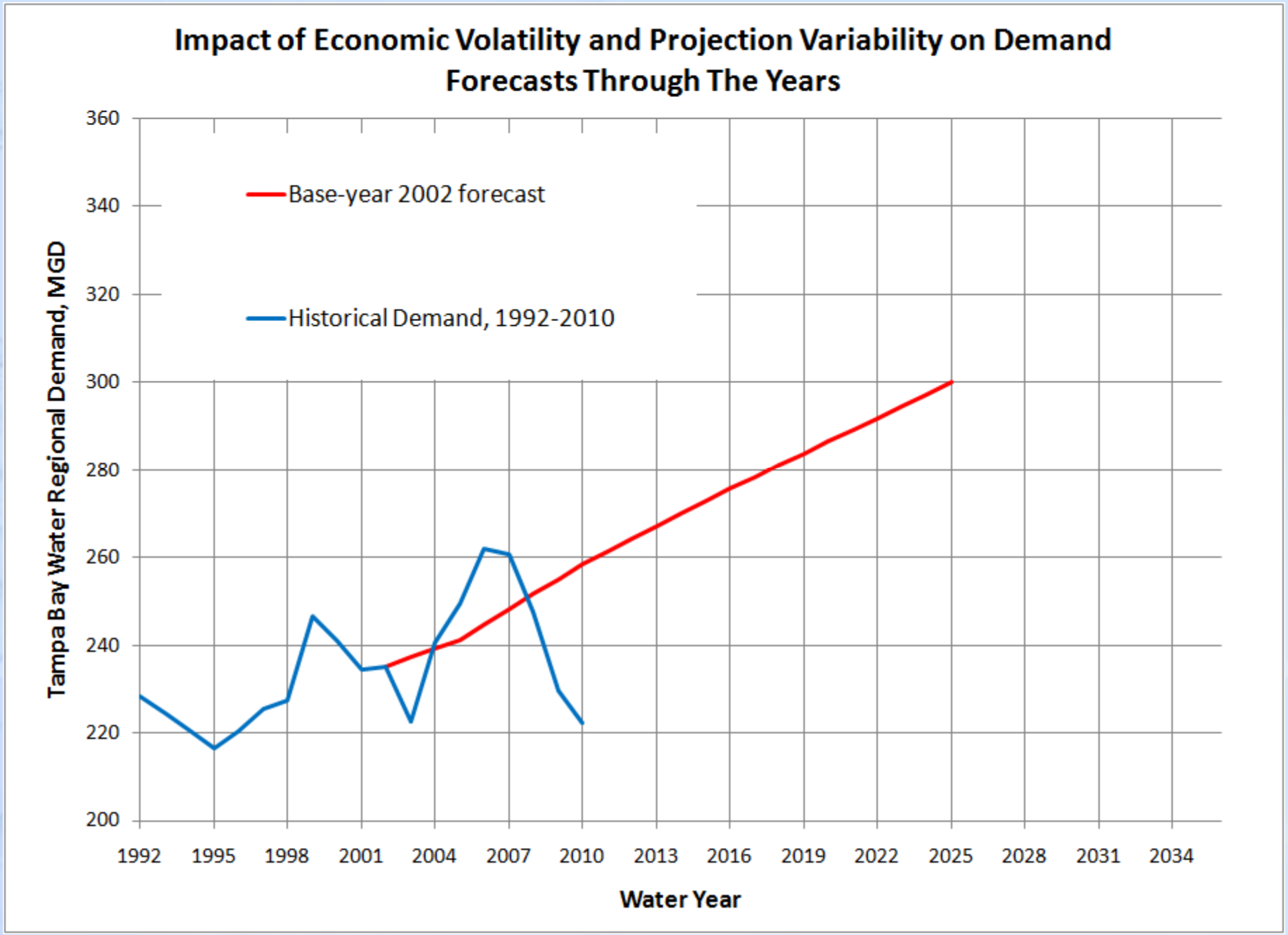
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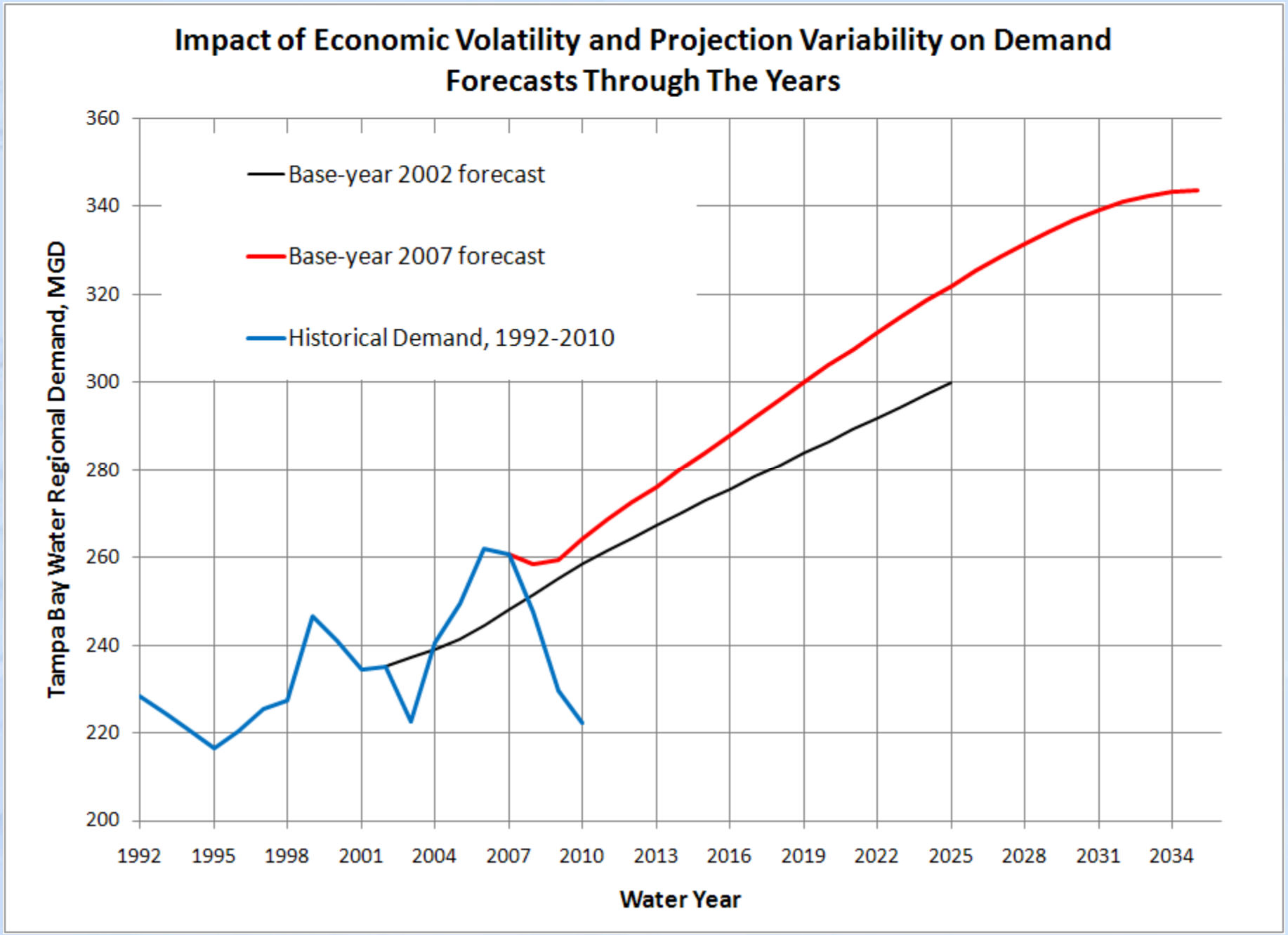
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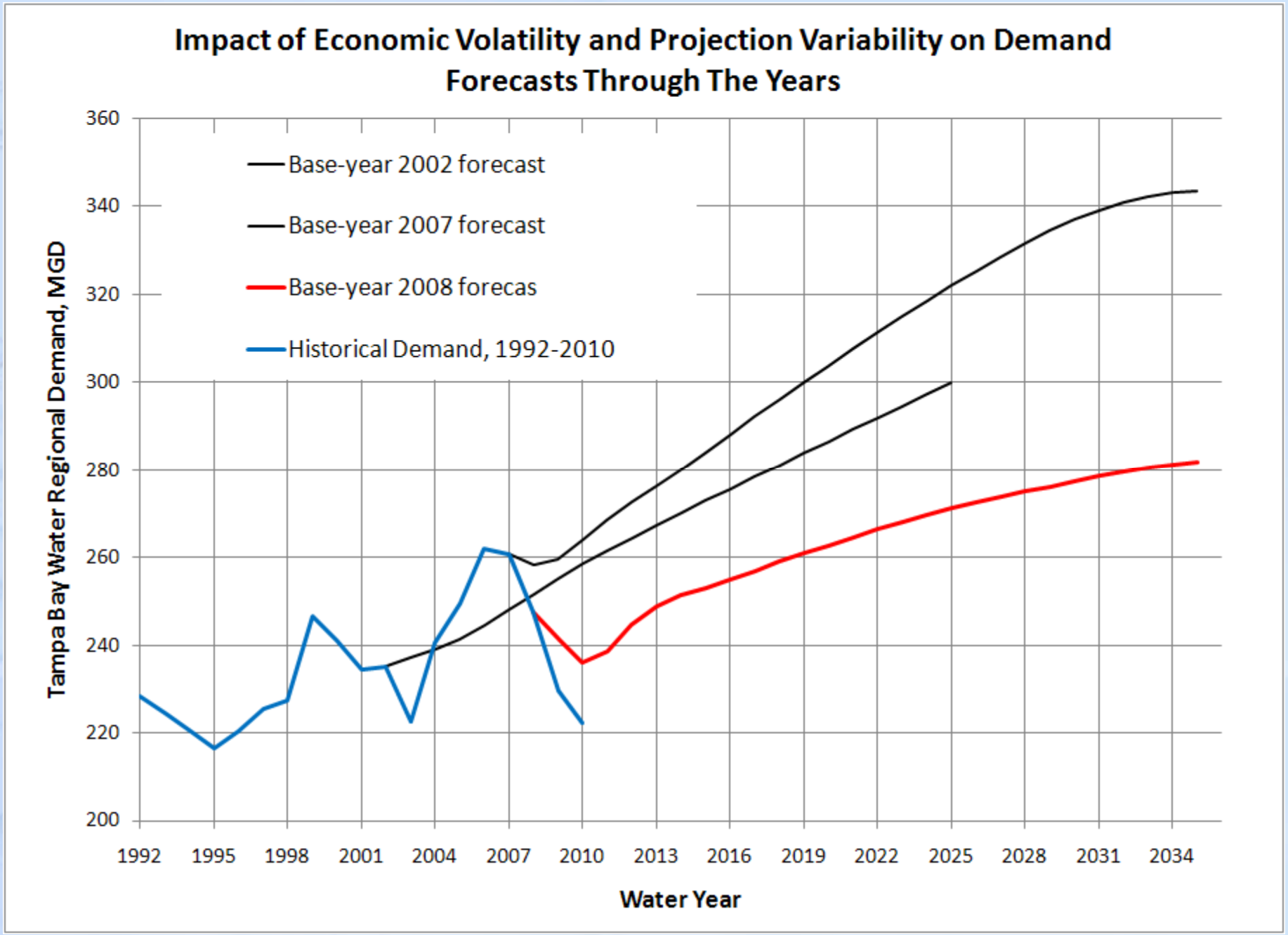
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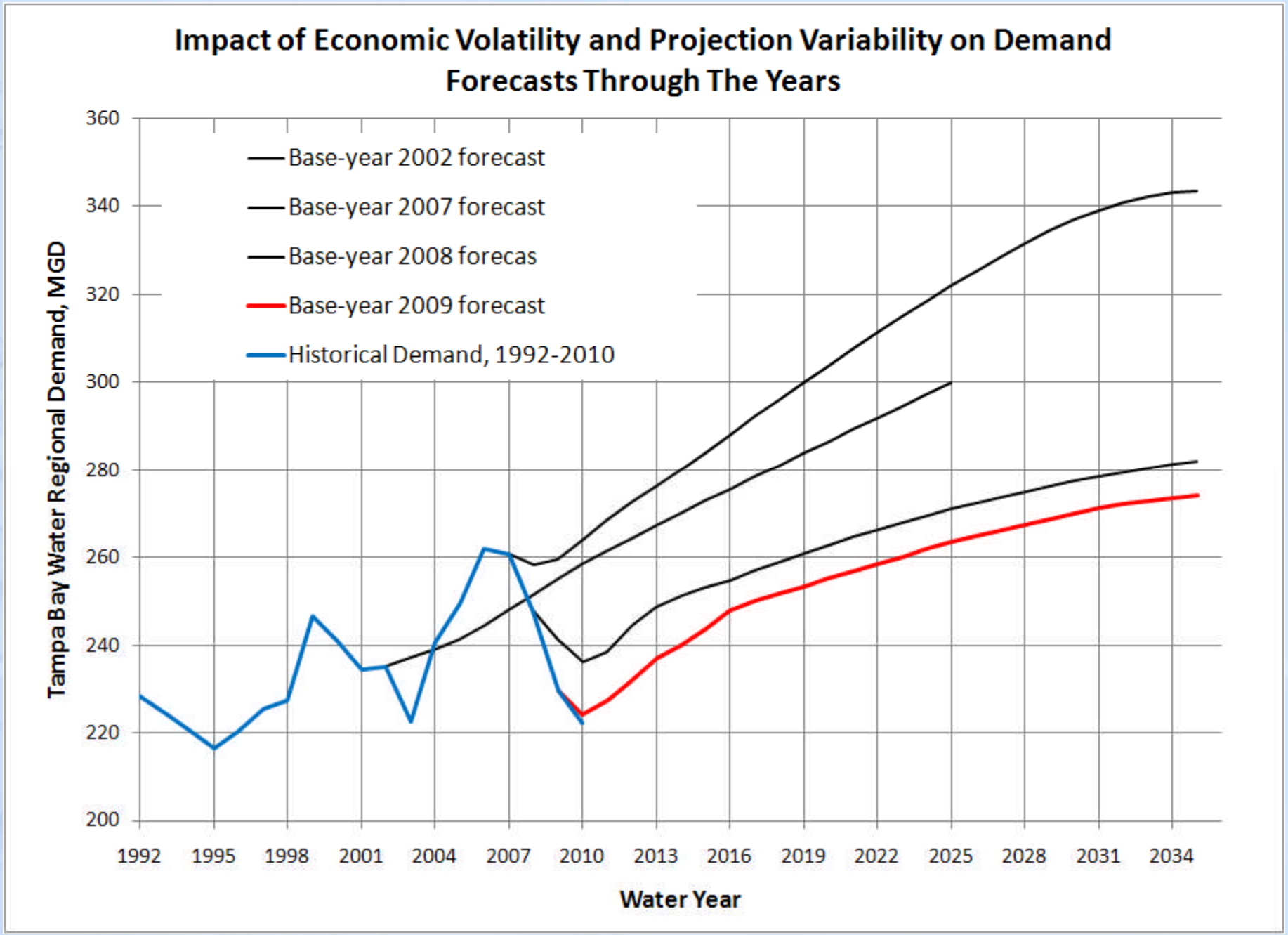
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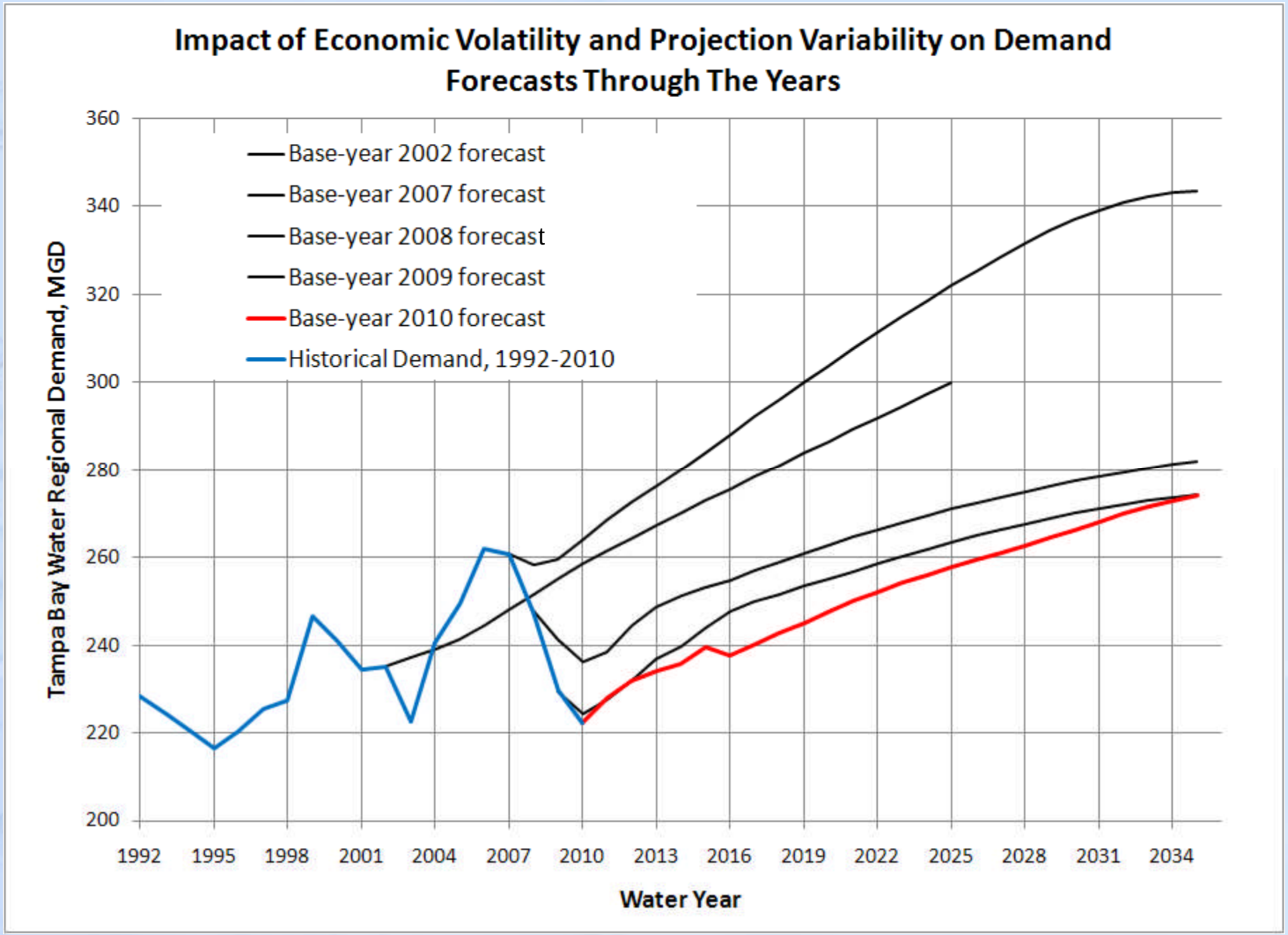
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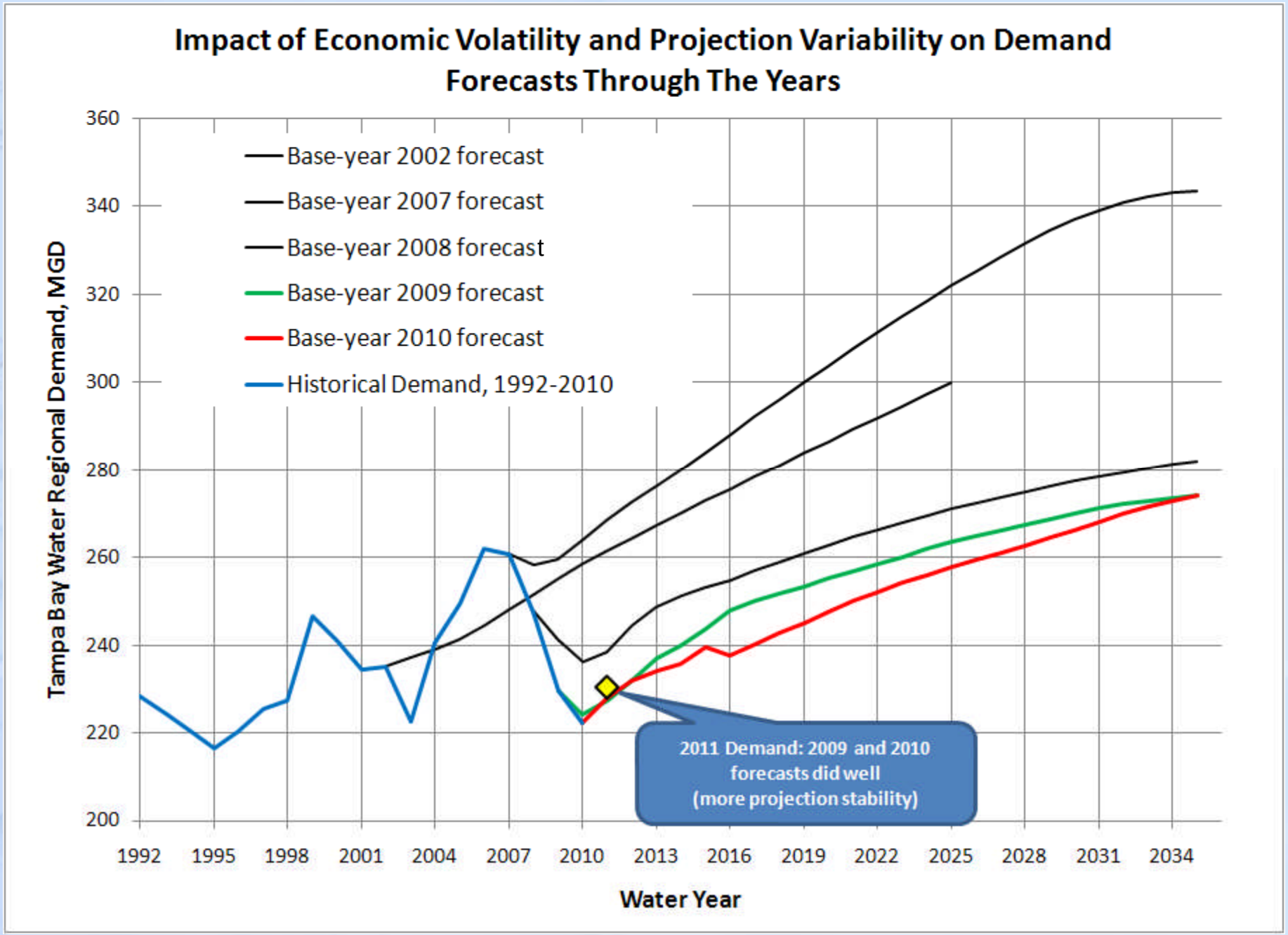
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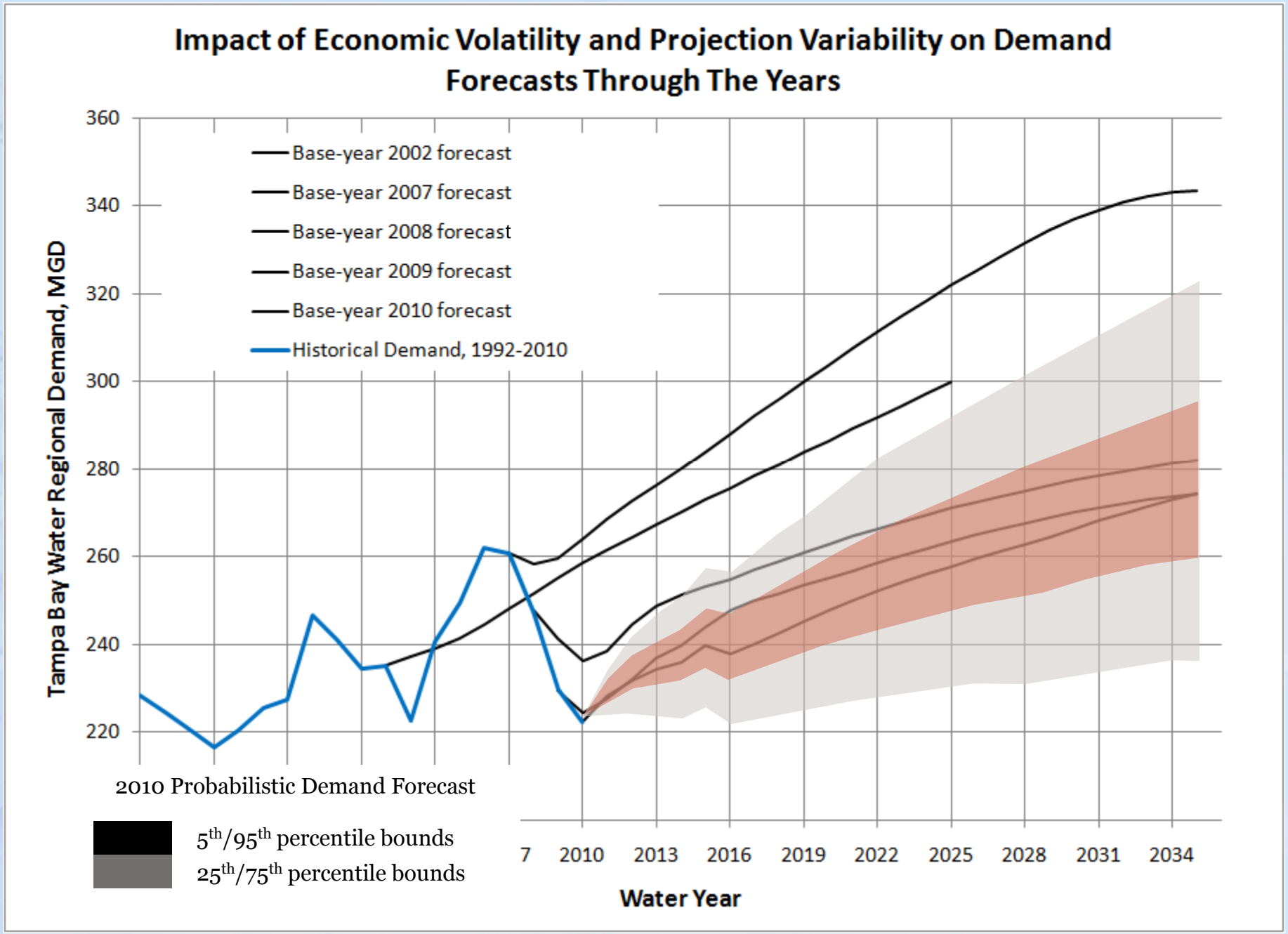
2011 Demand: 2009 and 2010 forecasts did well (more projection stability)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Historical Demand, 1992-2010
2010 Probabilistic Demand Forecast
5th/95th percentile bounds
25th/75th percentile bounds
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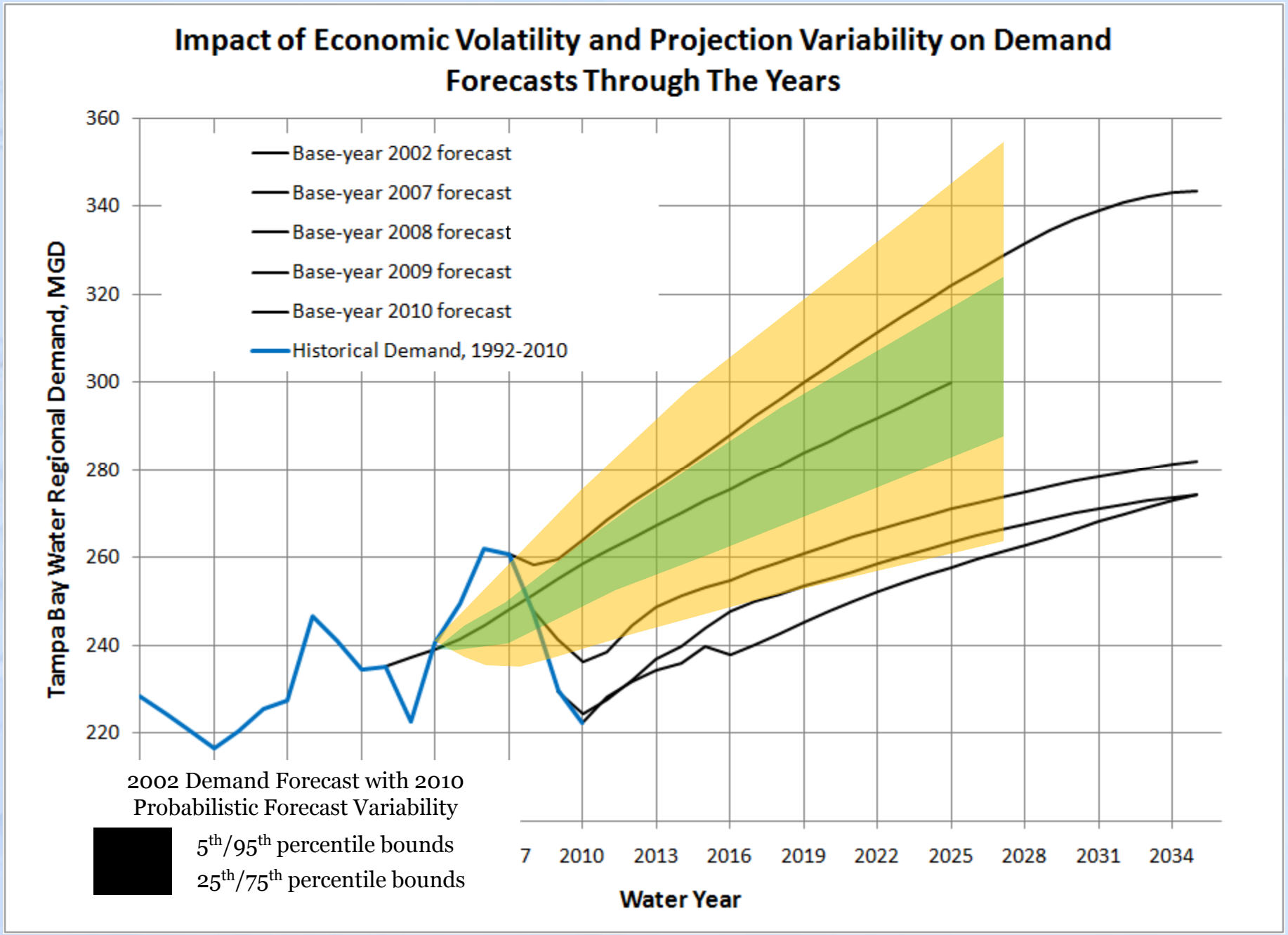
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2002 Demand Forecast with 2010 Probabilistic Forecast Variability
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Closing Observations

- Contemplating and categorizing influential factors easier than measuring their impacts on water use
- Recent acute decreases in water use have brought attention to long-term structural factors and other trends
- Forecasts tend to be optimistic in boom times and more pessimistic in bust times
  - For some, the outlook may be dismal when compounded by greater efficiency and changing norms!

Closing Observations

- The long-run is defined by the end of a string of short runs
  - Updates to forecasts of socioeconomic trends seem often to be "reactive"
  - Downward (or upward) "resets" of previous forecasts
- Recent deep recession may provide an opportunity to differentiate *some* of the signals from *some* factors

There is still potential upward demand pressure

Range of Estimated Projected Changes in Mean Annual Demand by Case Utility and Climate Projection Year

Utility	Δ Mean Estimated Demand 2055 Climate (%)		Δ Mean Estimated Demand 2090 Climate (%)	
	Min	Max	Min	Max
Colorado Springs Utilities	5.9%	23.2%	7.7%	45.0%
Durham Region (Ontario)	1.6%	4.3%	2.0%	8.3%
MWRA (Massachusetts)	1.7%	5.0%	2.5%	9.1%
SNWA (Nevada)	3.9%	9.4%	5.2%	15.5%
San Diego County	3.5%	12.7%	9.2%	23.7%
Tampa Bay Water	1.2%	5.3%	2.1%	9.9%

Source: Kiefer et al., 2013 (forthcoming), Analysis of Changes in Water Use under Regional Climate Change Scenarios, Water Research Foundation, Denver.

Thank You

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618-889-0498