ESTIMATING POTENTIAL OUTPUT IN THE PHILIPPINES

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INTRODUCTORY REMARKS

- Based on an on-going consulting project of the authors with the Bangko Sentral ng Pilipinas (BSP), the Central Bank of the Philippines

- Most of the results presented here are reported in the BSP Working Paper "Review of the Potential Output and Output Gap Estimation Models of the Bangko Sentral ng Pilipinas," (October 2018), coauthored by us with BSP staff officers Veronica Bayangos, Faith Cacnio, and Marites Oliva.

INTRODUCTORY REMARKS

Reliable estimates of the economy's potential output are particularly important for inflation targeting and monetary policy setting in the Philippines. This presentation reviews the alternative modeling approaches utilized by BSP as it embarked on an effort to

1. Strengthen the structural framework of the analysis,
2. Capture labor market dynamics and financial cycle developments, and
3. Improve the inflation forecasts in its inflation targeting program

PRESENTATION OUTLINE

- Alternative approaches to measuring potential output
- Introduction of financial conditions index and r labor market conditions index
- Estimates of potential output and total factor productivity
- Combining forecasts of output gap and impact on inflation forecasting
- Policy implications
- Concluding remarks

ALTERNATIVE APPROACHES TO ESTIMATING POTENTIAL OUTPUT

1. Statistically-based filtering methods
2. Production function approach and TFP growth accounting
3. Broader macroeconomic-based modeling
   - Structural Vector Autoregression (SVAR) models
   - Macroeconomic Unobserved-Components Models (MUCM)

STATISTICALLY-BASED FILTERING METHODS

- Uses a weighted average of lags and leads of observed output

- Hodrick-Prescott (HP)
- Truncated HP
- HP-one sided
- Baxter-King (BK)
- Christiano-Fitzgerald (CF)
- Hamilton Filter

STATISTICALLY-BASED FILTERING METHODS

Estimated Potential Output Growth rate (%)	Current Models		BSP Latest Models	
	Latest Quarter	Last 2 years Average	Latest Quarter	Last 2 years Average
Hodrick-Prescott (HP)	6.5 (Q4 2016)	6.4 (Q1 2015 to Q4 2016)	5.7 (Q2 2016)	5.9 (Q3 2014 to Q2 2016)
Truncated HP	5.7 (Q4 2016)	6.0 (Q1 2015 to Q4 2016)		
HP-one sided			6.6 (Q2 2016)	6.5 (Q3 2014 to Q2 2016)
Baxter-King (BK)			6.7 (Q2 2013)	5.9 (Q3 2011 to Q2 2013)
Christiano-Fitzgerald (CF)			4.9 (Q2 2016)	5.8 (Q3 2014 to Q2 2016)
Hamilton Filter			6.6 (Q2 2016)	6.7 (Q3 2014 to Q2 2016)

PRODUCTION FUNCTION APPROACH

- Relates real GDP to labor employment and capital
- Alternative specifications and innovations
  - Full-time-equivalent (FTE) employment, labor quality in terms of educational attainment, and replacing headcount with hours worked.
  - Account for structural breaks during the estimation period

Estimated Potential Output Growth rate (%) Using FTE Employment	Current Models		BSP Latest Models	
	Latest Quarter	Last 2 years Average	Latest Quarter	Last 2 years Average
Cobb-Douglas (CD)			6.8 (Q2 2016)	6.9 (Q3 2014 to Q2 2016)
CD with structural breaks			5.3 (Q2 2016)	5.4 (Q3 2014 to Q2 2016)
CD with restriction			7.3 (Q2 2016)	7.6 (Q3 2014 to Q2 2016)
CD with restriction and structural breaks			5.8 (Q2 2016)	5.8 (Q3 2014 to Q2 2016)
Linearized Constant Elasticity of Substitution (CES), a la Kmenta			12.7 (Q2 2016)	7.9 (Q3 2014 to Q2 2016)
Linearized CES, a la Kmenta with structural breaks			12.0 (Q2 2016)	7.4 (Q3 2014 to Q2 2016)
CES (using filtered inputs)	5.4 (Q4 2016)	5.3 (Q1 2015 to Q4	5.5 (Q2 2016)	5.6 (Q3 2014 to Q2 2016)

STRUCTURAL VECTOR AUTOREGRESSION (SVAR)

- Combines two aspects of behavior of real output:
  (1) joint interaction of GDP with other variables of interest
  (2) specific treatment of time dynamics in the behavior of endogenous variables through vector autoregressive component
- *Current model* - real GDP, FTE employment, real exchange rate, weighted average of interest rates, and national budget deficit relative to nominal GDP.
- *Latest model* - started with GDP and unemployment, coefficient restrictions are derived from the requirement that demand shock has no long-run effect on GDP

STRUCTURAL VECTOR AUTOREGRESSION (SVAR)

Estimated Potential Output Growth rate (%)	Current Models		BSP Latest Models	
	Latest Quarter	Last 2 years Average	Latest Quarter	Last 2 years Average
SVAR	5.5 (Q4 2016)	5.3 (Q1 2015 to Q4 2016)	7.5 (Q2 2016)	6.2 (Q3 2014 to Q2 2016)

MACROECONOMIC UNOBSERVED COMPONENTS MODEL (MUCM)

- Observed real GDP is modeled in terms of unobservable components (trend and cyclical)
- Provides avenues for more economic-theoretic considerations
- Two versions:

(1) First model – GDP and unemployment decomposed into two unobservable components

(2) Second model – GDP, unemployment, inflation, underemployment, financial conditions index, and labor market conditions index

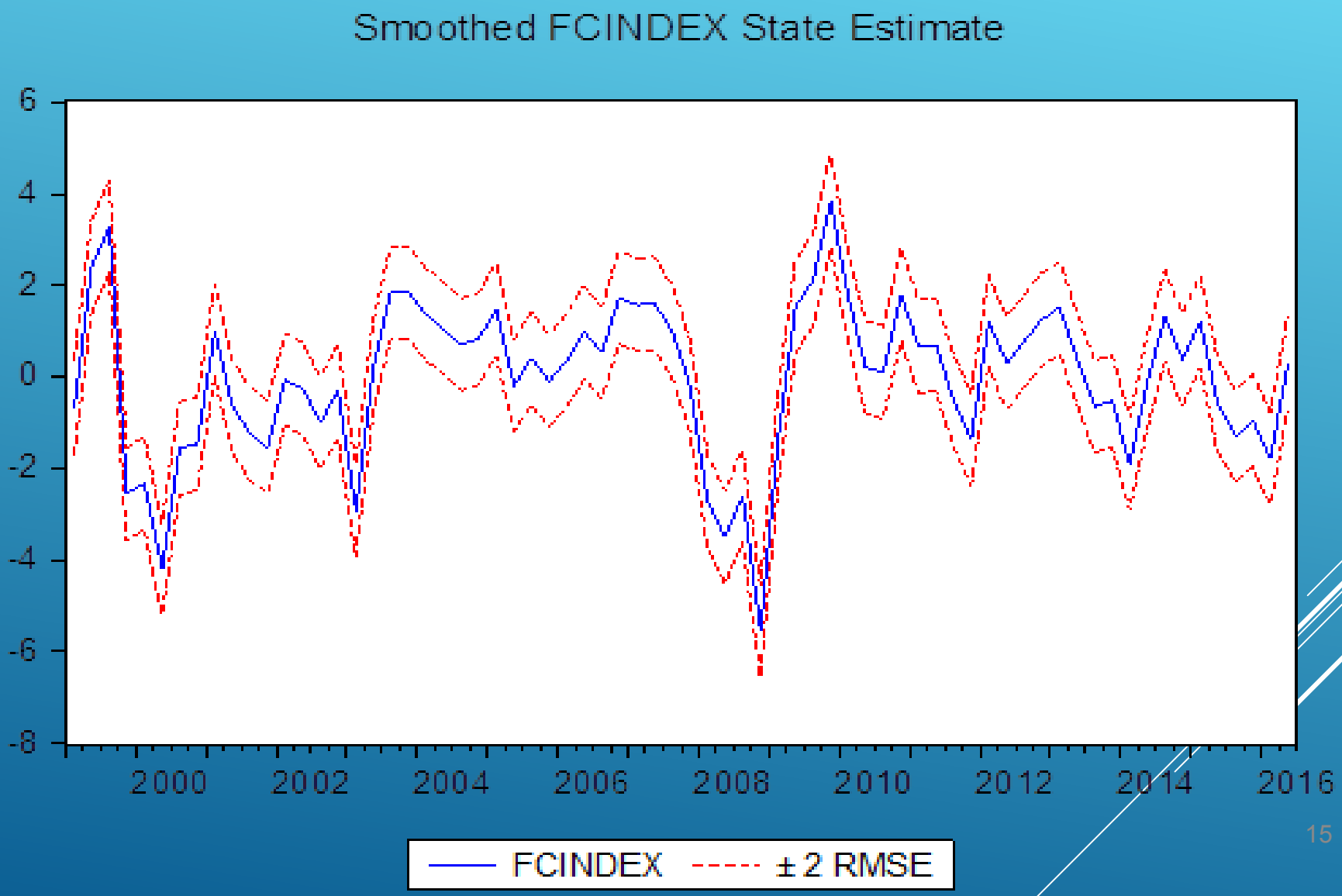
MACROECONOMIC UNOBSERVED COMPONENTS MODEL (MUCM)

Estimated Potential Output Growth rate (%)	Current Models		BSP Latest Models	
	Latest Quarter	Last 2 years Average	Latest Quarter	Last 2 years Average
MUCM1			5.9 (Q2 2016)	5.8 (Q3 2014 to Q2 2016)
MUCM2			6.3 (Q2 2016)	6.2 (Q3 2014 to Q2 2016)

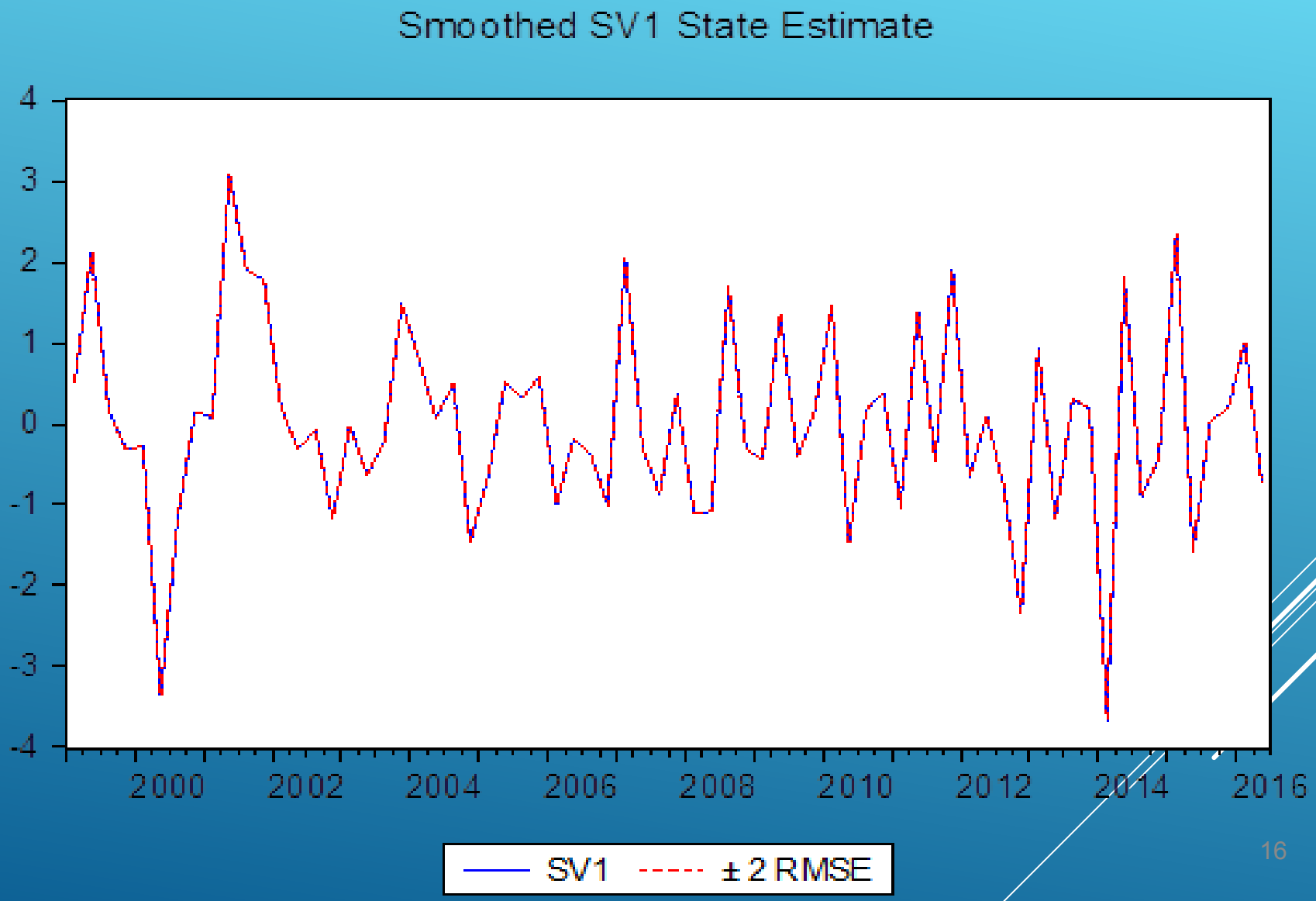
INDICES FOR FINANCIAL & LABOR MARKET CONDITIONS

- Based on relevant observable indicators
- Separate dynamic latent factor models(DLFM) to construct FCI and LMCI
- Computer intensive – so not too many indicators
  - US uses 105 indicators but in a simpler model; 19 indicators for their LMCI via DLFM
- Constructed series for FCI and LMCI are treated as exogenous variables in the output gap model – e.g., in MUCM2; similarly possible in the other models

FINANCIAL CONDITION INDEX



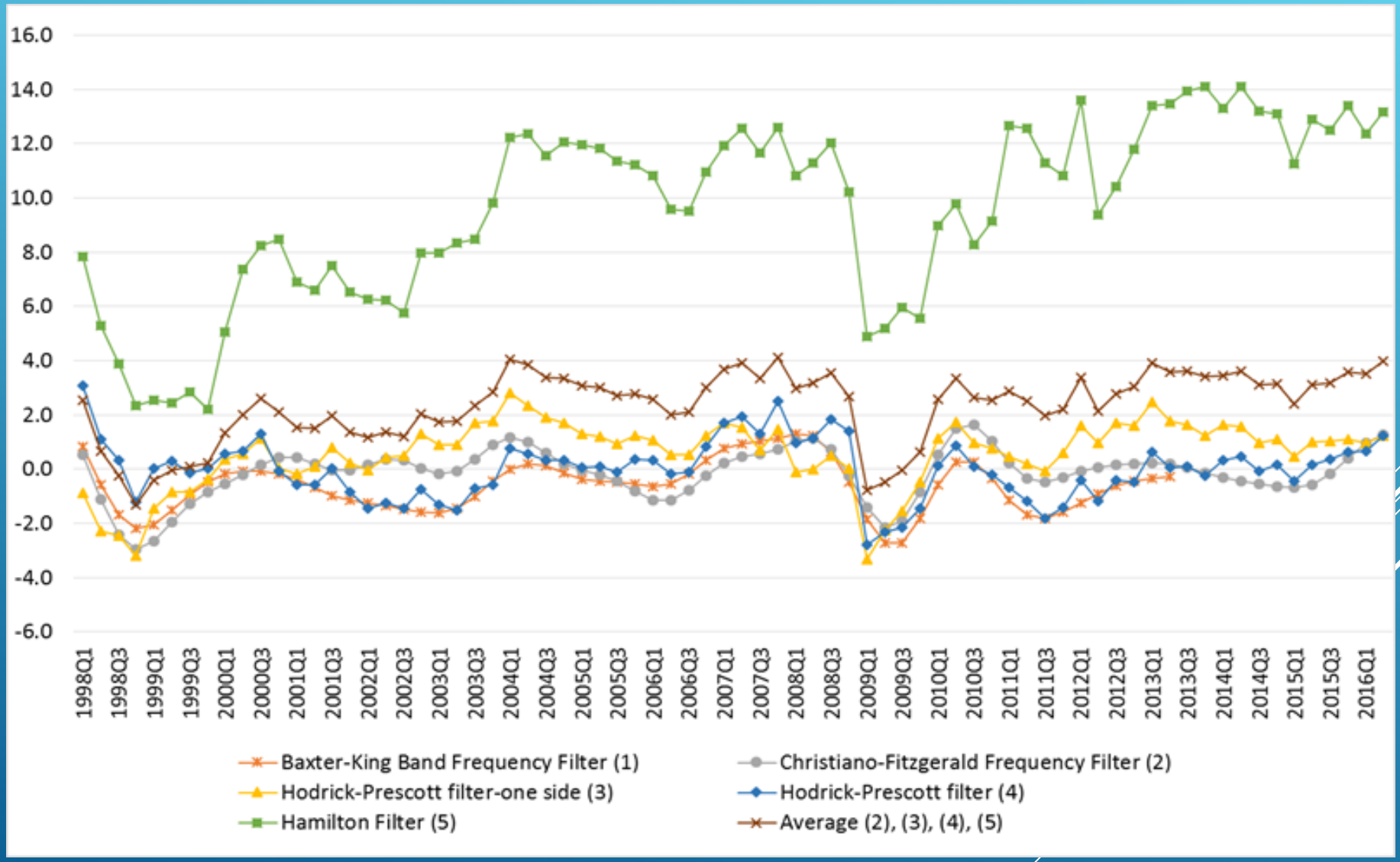
LABOR MARKET CONDITION INDEX



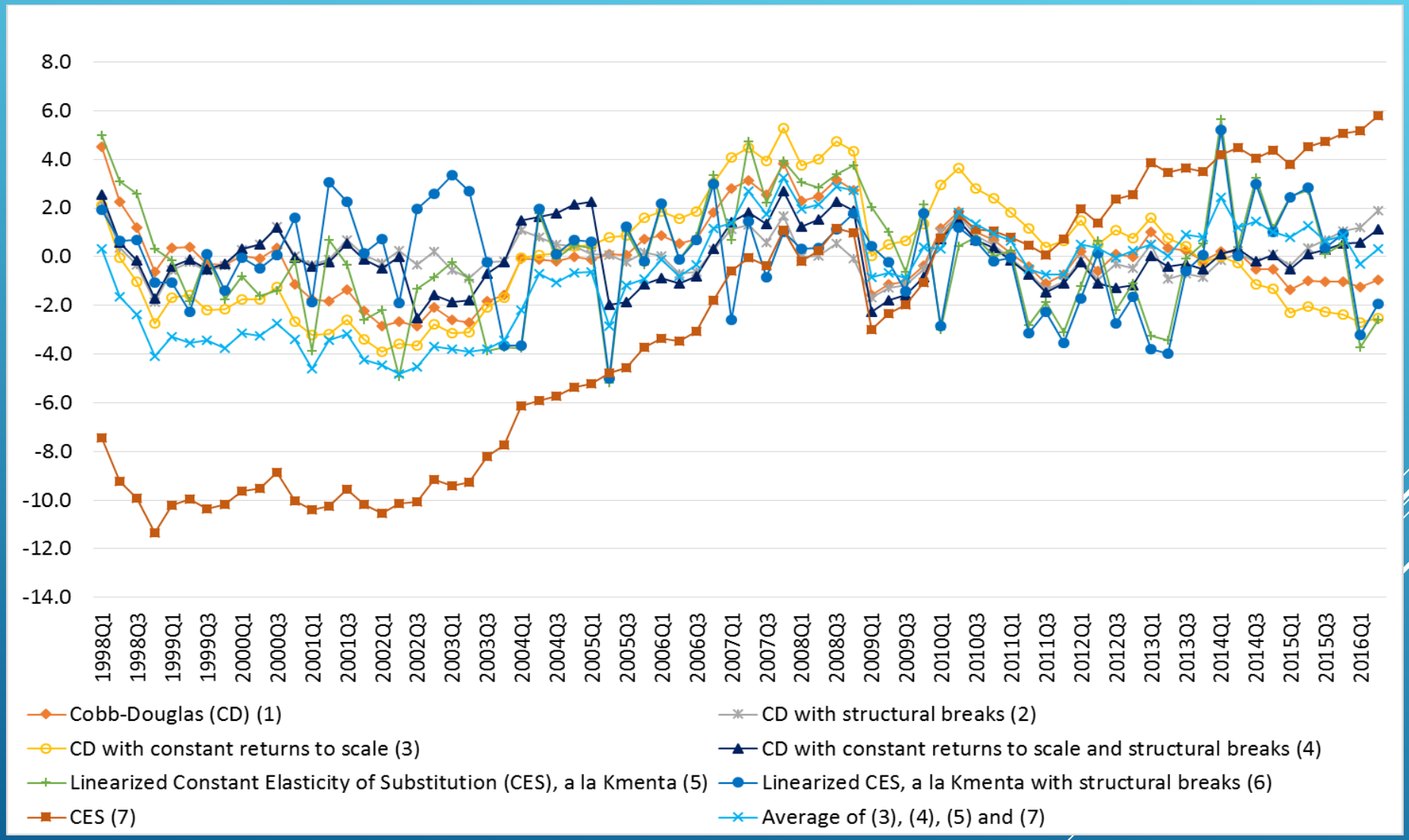
ESTIMATED POTENTIAL GDP GROWTH RATES

	2015 Q1-Q4	2016 Q1-Q2
Filter-average	6.18	5.90
Production function-average	6.58	8.10*
SVAR	6.13	6.40
MUCM1	5.83	5.90
MUCM2 (with FCI and LMCI)	5.98	6.25
Simple Average	6.10	6.49
MSE Rank weighted	6.05	6.40

OUTPUT GAP ESTIMATE: STATISTICALLY-BASED FILTERING METHODS



OUTPUT GAP ESTIMATE: PRODUCTION FUNCTION APPROACH –USING FTE



TOTAL FACTOR PRODUCTIVITY

- Underlying concept: TFP is measured in terms of growth in GDP left after accounting for growth in labor and capital, weighted by factor shares
- Alternative measures considered:
  - directly from actual data on GDP, Labor, and Capital - growth accounting, in terms of index and in terms of actual data
  - based on estimated production functions

TOTAL FACTOR PRODUCTIVITY

TFP: Average growth rate of 5-year cycle	Index Method	Basic Data	Production Function	
			Incremental	Total
Q1 2015	1.00	0.91	0.87	1.53
Q2 2015	0.84	0.79	0.76	1.42
Q3 2015	0.78	0.75	0.59	1.25
Q4 2015	0.76	0.75	0.53	1.19
Q1 2016	0.47	0.46	0.36	1.02
Q2 2016	0.57	0.57	0.29	0.95

COMBINING FORECASTS OF OUTPUT GAP AND USE IN INFLATION FORECASTING

- Combine estimates using weights that optimize forecast accuracy, which is based on forecast errors in inflation arising from alternative models of output gap.
- Use auxiliary time-series regressions of actual inflation on estimated output gap to link inflation forecast errors to output gap estimates
- Resulting summary error statistics are used as weights in averaging the output gap, applied in a nested way.
- Statistical tests for encompassing and for comparing forecast accuracy (e.g., Diebold-Mariano test) are used further to assess relative merits of alternative averaging weights.

CONCLUDING REMARKS

- Review of BSP's alternative models for potential output estimation
- FCI and LMCI as additional components of the model
- Empirical results and policy implications
- Data limitations
- Future Directions
  - Improved treatment of FCI & LMCI
  - Expand MUCM as an inflation forecasting model

THE END

ADDITIONAL SLIDES

PRODUCTION FUNCTION APPROACH

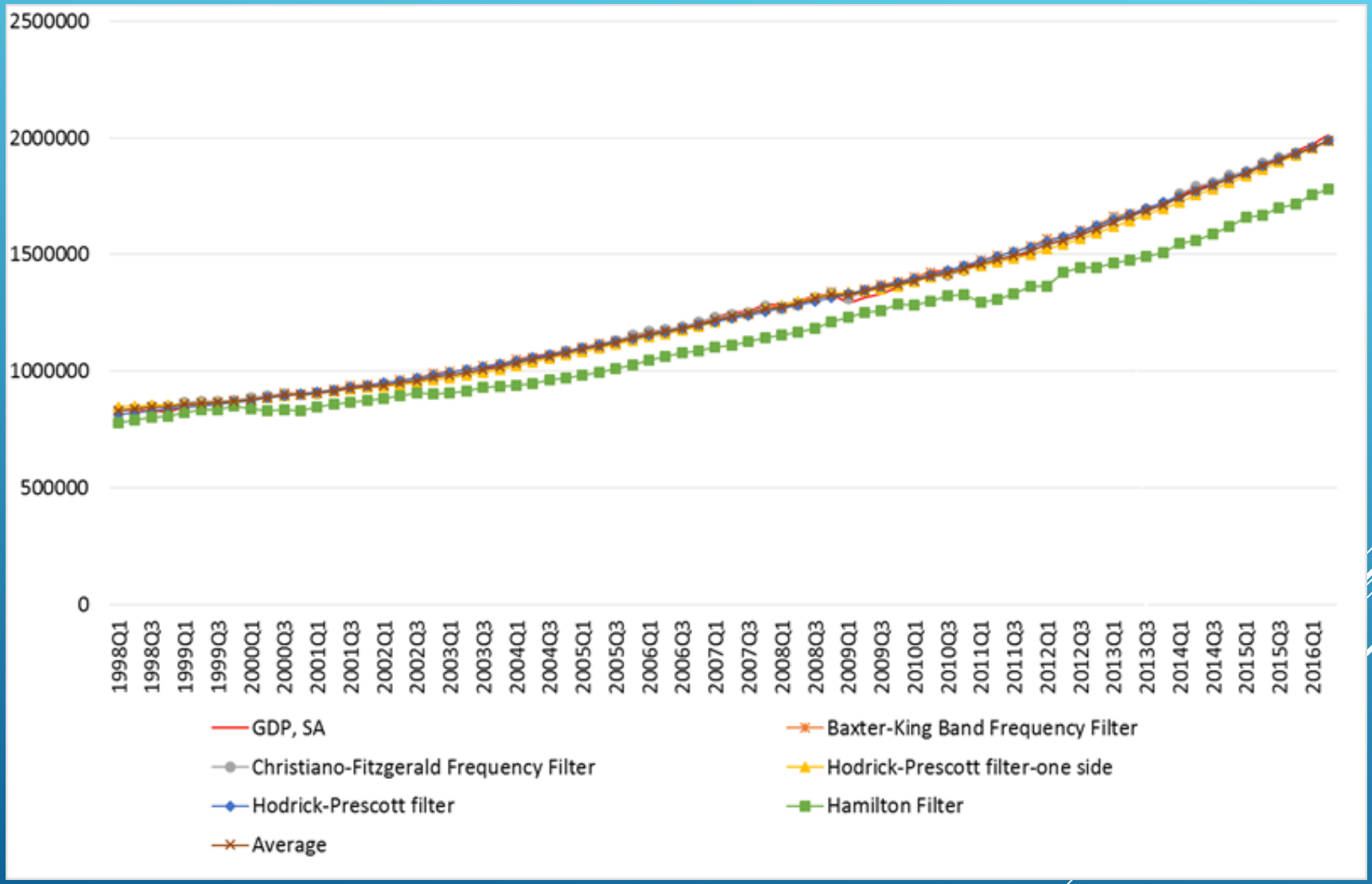
- Alternative specifications and innovations

Estimated Potential Output Growth rate (%) Using Education-weighted Employment	Current Models		BSP Latest Models	
	Latest Quarter	Last 2 years Average	Latest Quarter	Last 2 years Average
Cobb-Douglas (CD)			6.8 (Q4 2015)	6.8 (Q1 2014 to Q4 2015)
CD with structural breaks			6.7 (Q4 2015)	6.7 (Q1 2014 to Q4 2015)
CD with restrictions			7.7 (Q4 2015)	7.7 (Q1 2014 to Q4 2015)
CD with restrictions and structural breaks			6.1 (Q4 2015)	6.1 (Q1 2014 to Q4 2015)
Linearized Constant Elasticity of Substitution (CES), a la Kmenta			6.0 (Q4 2015)	6.2 (Q1 2014 to Q4 2015)
Linearized CES, a la Kmenta with structural breaks			6.2 (Q4 2015)	5.7 (Q1 2014 to Q4 2015)

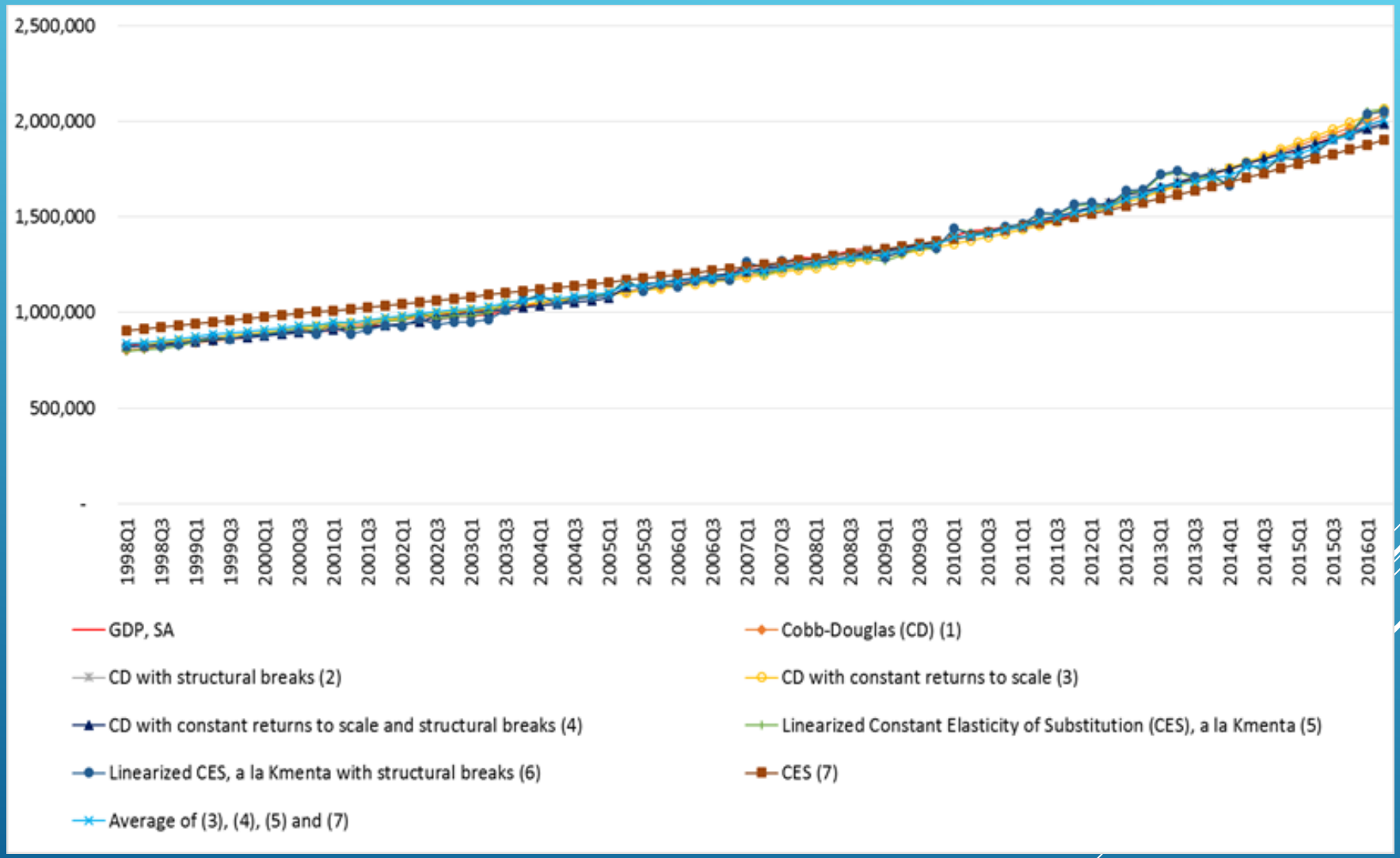
PRODUCTION FUNCTION APPROACH

Estimated Potential Output Growth rate (%) Using Hours Worked	Current Models		BSP Latest Models	
			Latest Quarter	Last 2 years Average
Cobb-Douglas (CD)			7.0 (Q4 2015)	7.0 (Q1 2014 to Q4 2015)
CD with structural breaks			6.6 (Q4 2015)	6.6 (Q1 2014 to Q4 2015)
CD with restrictions			7.6 (Q4 2015)	7.6 (Q1 2014 to Q4 2015)
CD with restrictions and structural breaks			6.6 (Q4 2015)	6.6 (Q1 2014 to Q4 2015)
Linearized Constant Elasticity of Substitution (CES), a la Kmenta			8.4 (Q4 2015)	7.5 (Q1 2014 to Q4 2015)
Linearized CES, a la Kmenta with structural breaks			8.0 (Q4 2015)	5.2 (Q1 2014 to Q4 2015)
CES			5.2 (Q4 2015)	5.2 (Q1 2014 to Q4 2015)

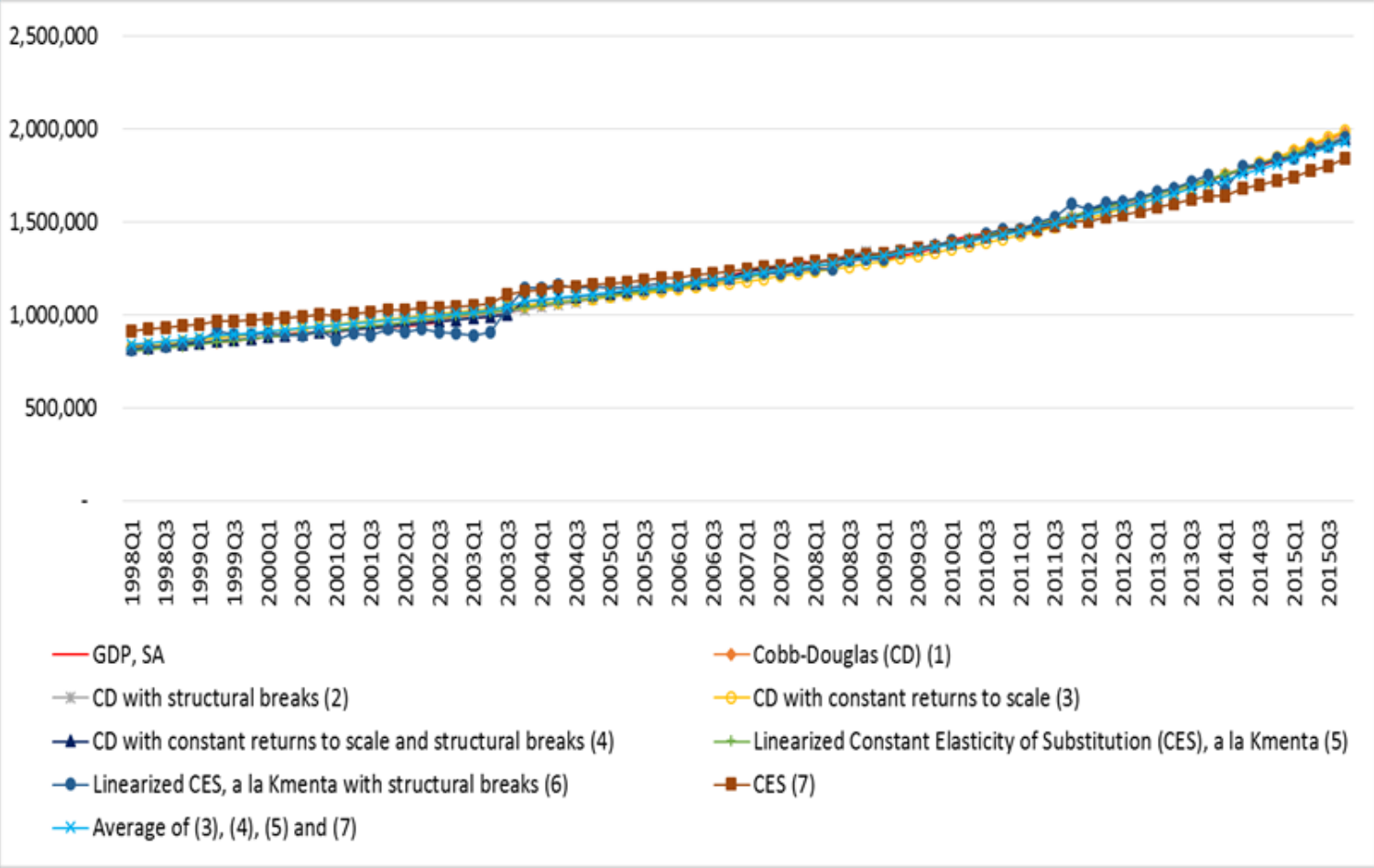
POTENTIAL OUTPUT ESTIMATE: STATISTICALLY-BASED FILTERING METHODS



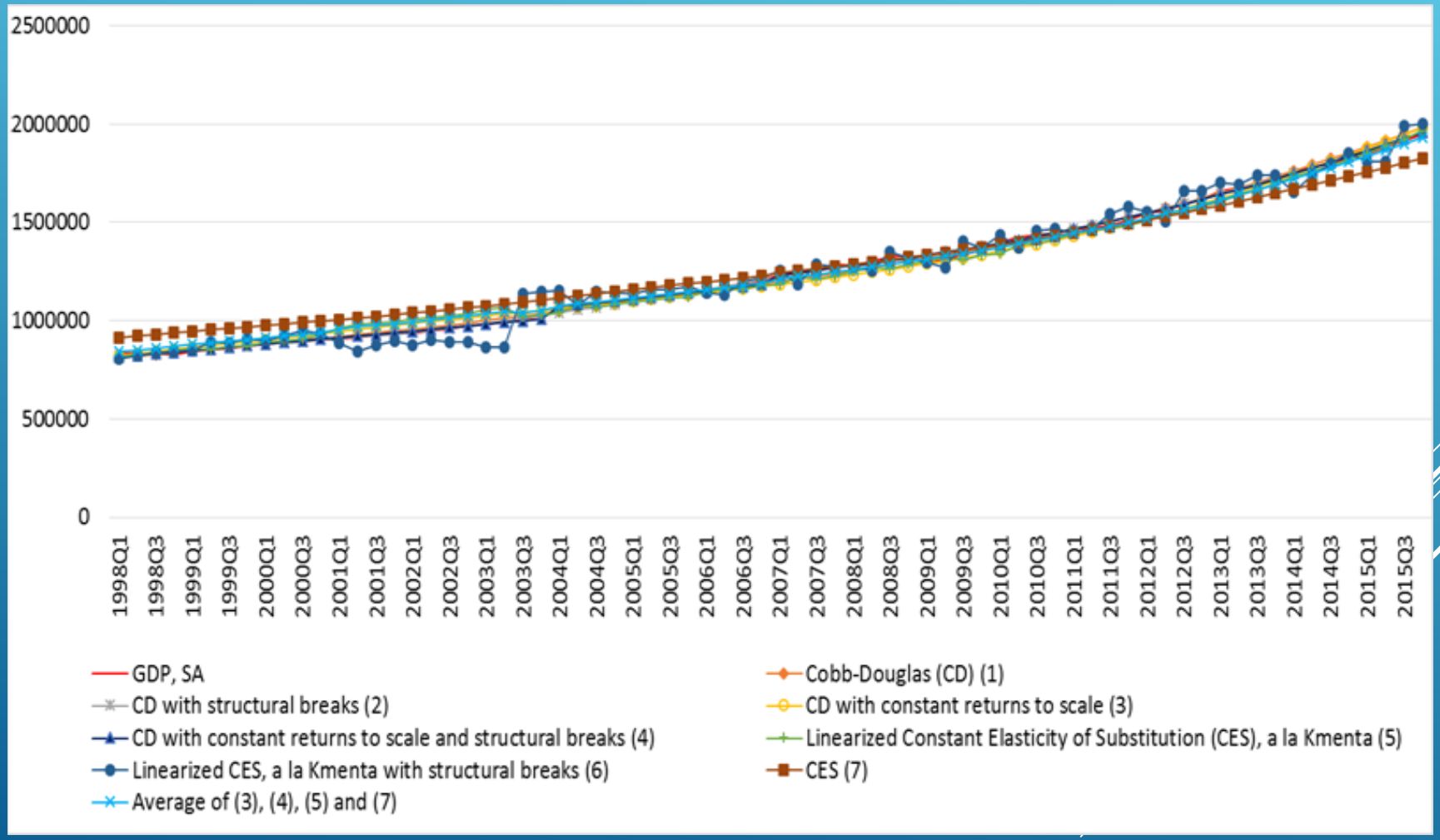
POTENTIAL OUTPUT ESTIMATE: PRODUCTION FUNCTION APPROACH –USING FTE



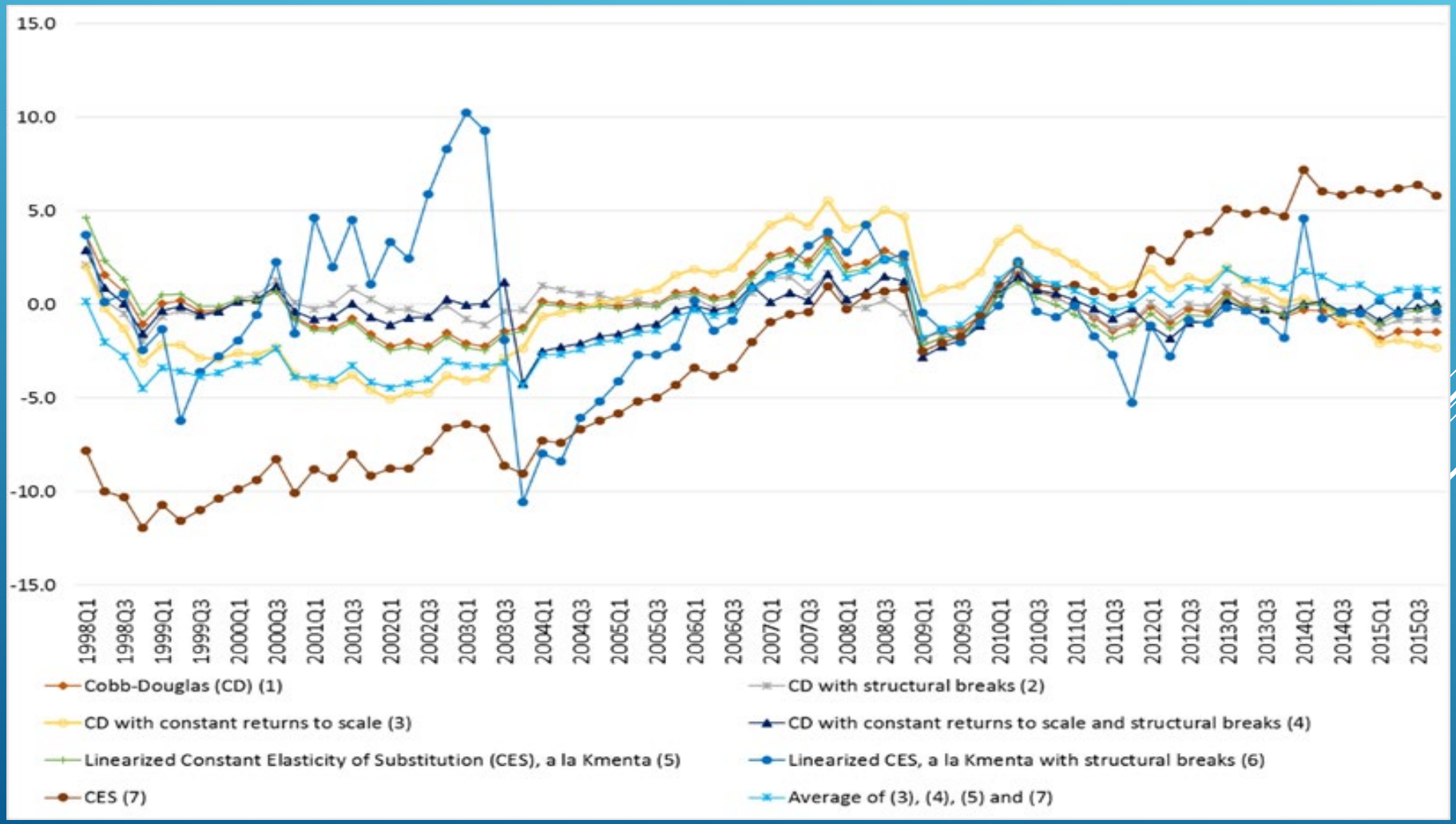
POTENTIAL OUTPUT ESTIMATE: PRODUCTION FUNCTION APPROACH – USING EDUCATION-WEIGHTED LABOR DATA



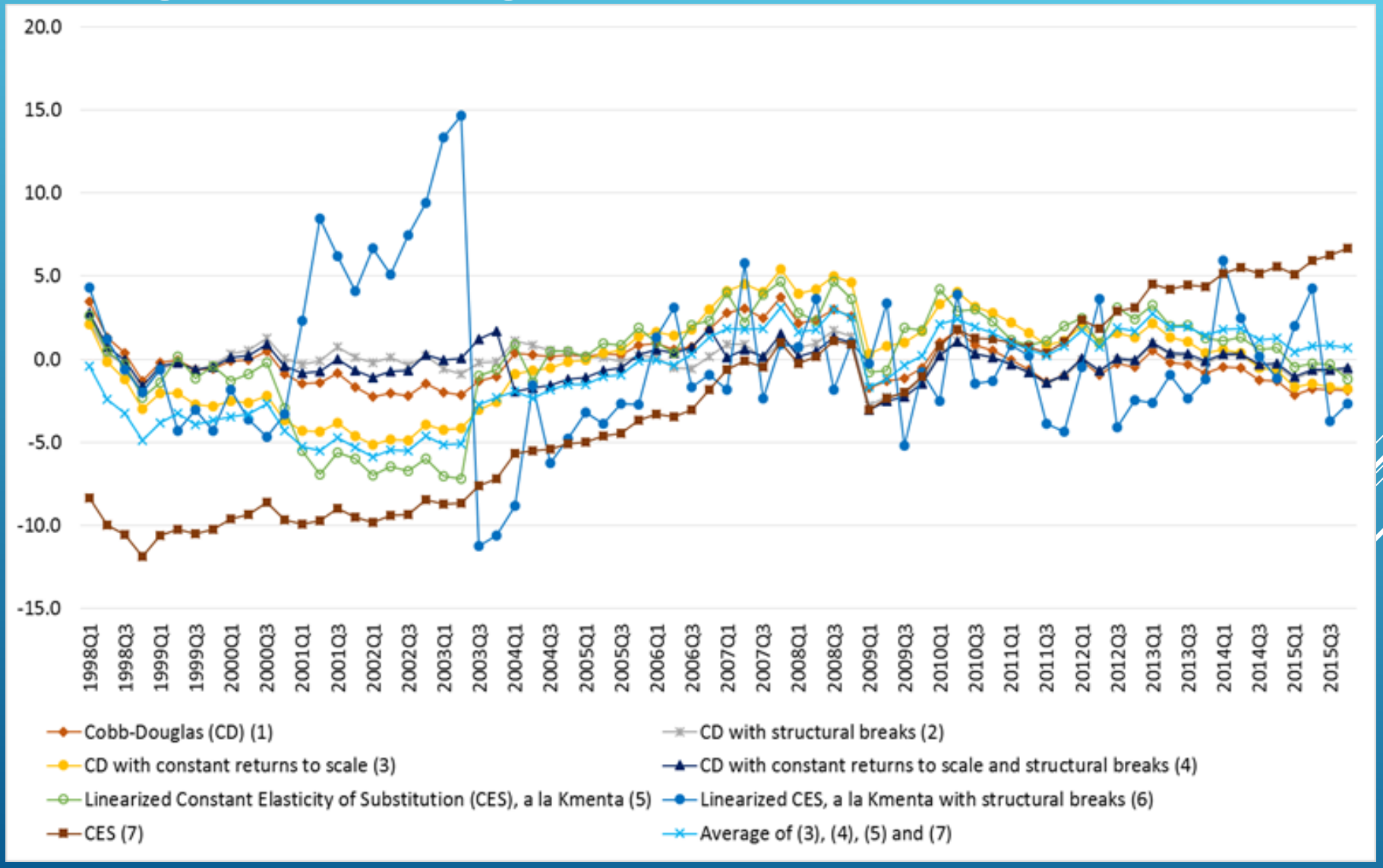
POTENTIAL OUTPUT ESTIMATE: PRODUCTION FUNCTION APPROACH – USING HOURS WORKED LABOR DATA



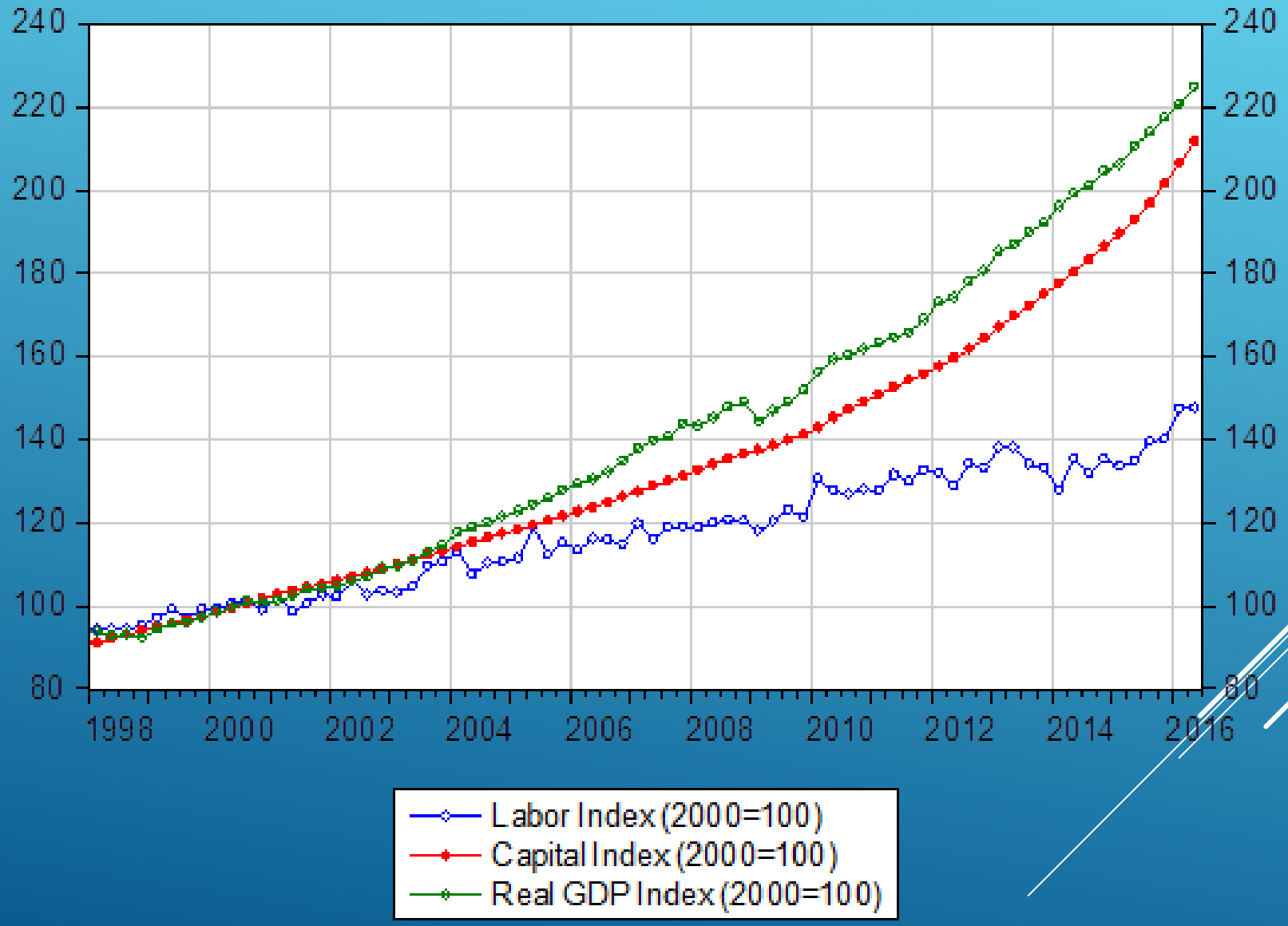
OUTPUT GAP ESTIMATE: PRODUCTION FUNCTION APPROACH – USING EDUCATION-WEIGHTED LABOR DATA



OUTPUT GAP ESTIMATE: PRODUCTION FUNCTION APPROACH – USING HOURS WORKED LABOR DATA



INDICES FOR LABOR, CAPITAL, AND GDP



INDICES FOR LABOR AND TOTAL FACTOR PRODUCTIVITY