New Estimates of Sri Lanka's TFP Growth

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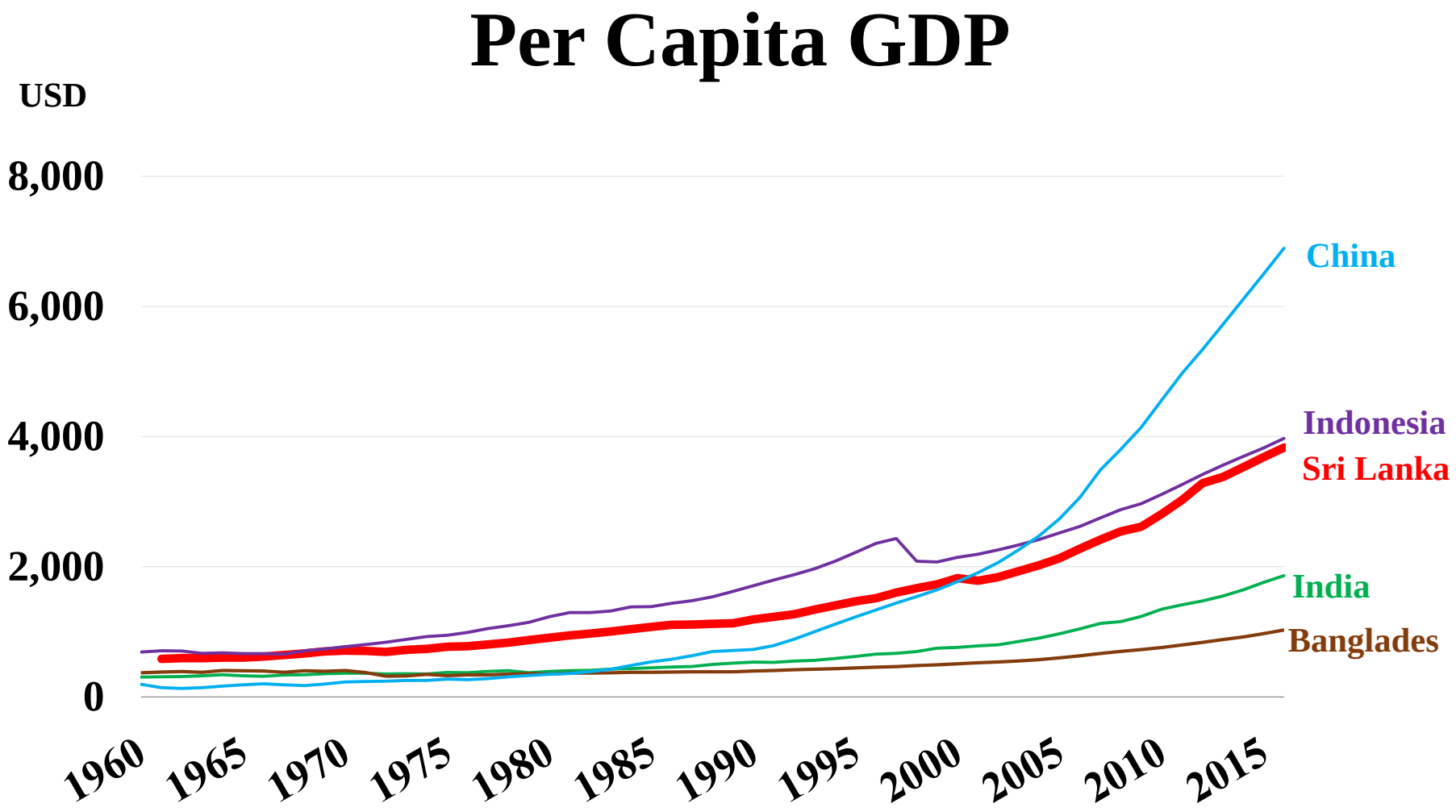
Presentation Outline

1. **Motivation**
2. **Research Objective and Questions**
3. **Literature Review and Research Gap**
4. **Data and Methods**
5. **Findings**
6. **Extensions**
7. **Conclusions**

1. Motivation



2. Research Objective, Hypothesis and Questions

Objective of the study

Identify Sri Lanka's sources of growth during 1980 - 2016, by calculating TFP growth under both **primal** and **dual** approaches

Research Questions

1. What are the TFPG estimates for Sri Lanka?
2. Does TFPG significantly contribute to Sri Lanka's long term growth?
3. What are the reasons for the divergence in estimates?
4. Are Sri Lanka's TFPG estimates different from its peers?
5. Are TFPG estimates sensitive to model's assumptions?

3. Literature Review and Research Gap

Current Literature - Country Specific Studies

- Fernandez et al (2005); Duma (2007)
- Used the primal approach only

Our Contributions to the Literature

- Pioneering attempt at calculating dual TFPG for Sri Lanka
- An extension of Duma (2007) for primal TFPG, covering a longer time horizon from 1980 to 2016
- Identifies the underlying reasons for the divergence of results between primal and dual approaches
- Compare Sri Lanka's results with other South and East Asian Economies

4. Data and Methods

Primal Approach

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} \quad (1)$$

$$\hat{Y}_t = \hat{A}_t + \alpha \hat{K}_t + (1-\alpha)\hat{L}_t \quad (2)$$

$$\hat{A}_t = \hat{Y}_t - \alpha \hat{K}_t - (1-\alpha)\hat{L}_t \quad (3)$$

Dual Approach

$$Y_t = r_t K_t + w_t L_t \quad (4)$$

$$\hat{Y}_t = s_K \hat{r}_t + s_K \hat{K}_t + s_L \hat{w}_t + s_L \hat{L}_t \quad (5)$$

$$\hat{Y}_t - s_K \hat{K}_t - s_L \hat{L}_t = s_K \hat{r}_t + s_L \hat{w}_t \quad (6)$$

$$\hat{A}_t = s_K \hat{r}_t + s_L \hat{w}_t \quad (7)$$

Duality

$$\Delta a_t = \Delta y_t - \alpha \Delta k_t - (1-\alpha)\Delta l_t = \alpha \Delta r_t + (1-\alpha)\Delta w_t \quad (8)$$

4. Data and Methods

Both primal and dual approaches have their own pros and cons

Primal Approach

- National accounts must be accurate in measuring factor stocks (capital and labour)
- But, there could be measurement errors and unavailability of data

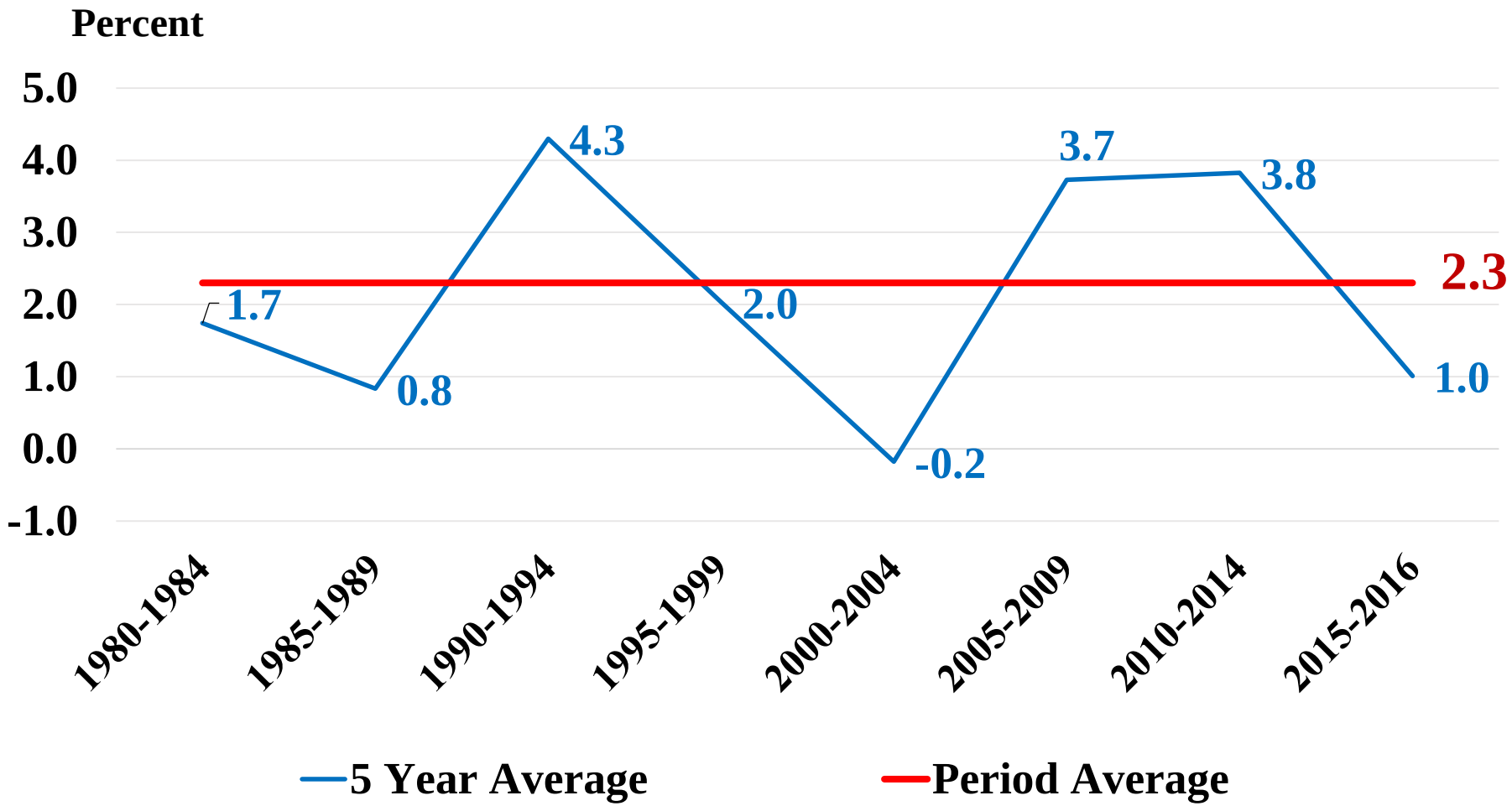
Dual Approach

- Uses factor prices instead of factor quantities
- Prices are better measures as can be observed in the markets, but markets must be competitive
- Unlike primal approach, the only assumption required is: output = factor incomes

4. Data and Methods

Primal		Dual	
Variable	**Source**	**Variable**	**Source**
Real GDP (Y)	World Development Indicators	Real Rental Rate (r)	Estimated: immovable property lending rate, CPI - CBSL
Capital Stock (K)	Estimated using Perpetuity Inventory Method	Real Wage (w)	Estimated: CBSL real wage index
Labour Stock (L)	DCS, CBSL, Interpolated	Capital Share (α) = .3	As in Primal
Human Capital (HC)	UN Education Index, Interpolated		
Capital Share (α) = .3	Literature		
δ = 6.7%, 10%, 6.7%	Literature/Assumed		

5. Findings - Primal TFPG Results



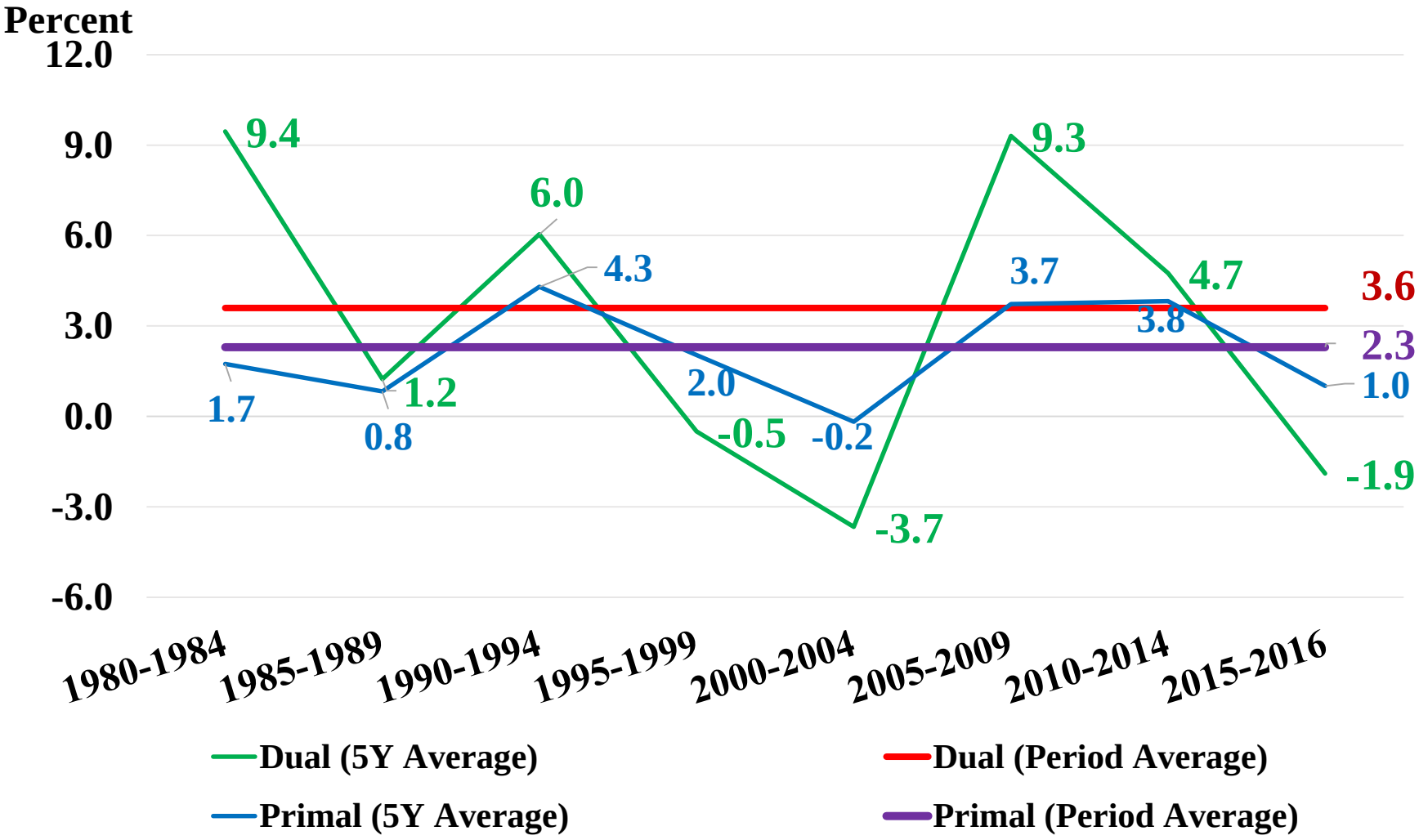
TFPG is erratic and over the period average is 2.3%

5. Findings - Decomposition of Sources of Growth

Period	Rationale	GDP Growth	Capital Growth	Labour Growth	TFP Growth
				%	
1980-1984	Open economy/LTTE	5.1	3.0	0.3	1.7
1985-1989	LTTE/JVP insurrection	3.2	1.5	0.9	0.8
1990-1994	Ealam War II	5.6	1.2	0.1	**4.3**
1995-1999	Ealam War III	4.9	1.6	1.3	2.0
2000-2004	Peace with LTTE	4.0	1.4	2.7	**-0.2**
2005-2009	Ealam War IV	6.0	2.2	0.1	3.7
2010-2014	Peace after end of war	6.8	3.0	0.0	3.8
2015-2016	Coalition Government	4.6	2.5	1.1	1.0
1980-2016	37 Years	5.1	2.0	0.8	**2.3**

TFPG Contribution to GDP Growth is 45% during 1980-2016

5. Findings - Movements of Primal and Dual TFPG



Though there are some differences in estimates, over the period both series have similar trends: primal 2.3%, dual 3.6 %

5. Findings - Reasons for Differences in Estimates

1. Underestimation of Primal

Underestimation of national accounts

- Poor coverage of conflict areas – understated output
- Non-inclusion of the Informal sector – understated output

2. Overestimation of Dual

Market imperfections

- Capital market restrictions – higher return to capital
- Taxes – higher wage
- Union actions/minimum wages – higher wage

6. Extensions to the main Study

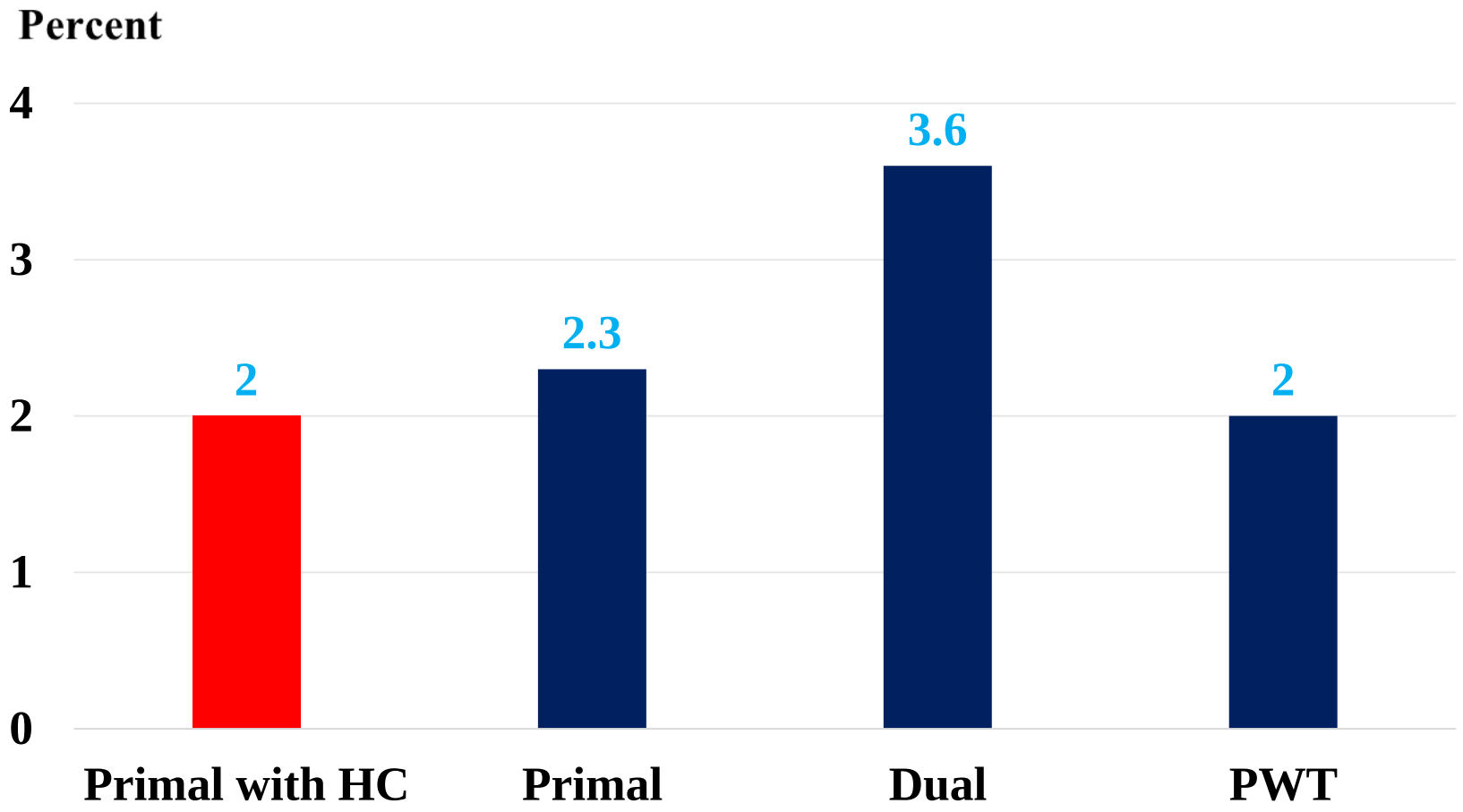
1. Inclusion of Human Capital to the model as the third factor of production

2. Compare results with Penn World Table TFPG numbers

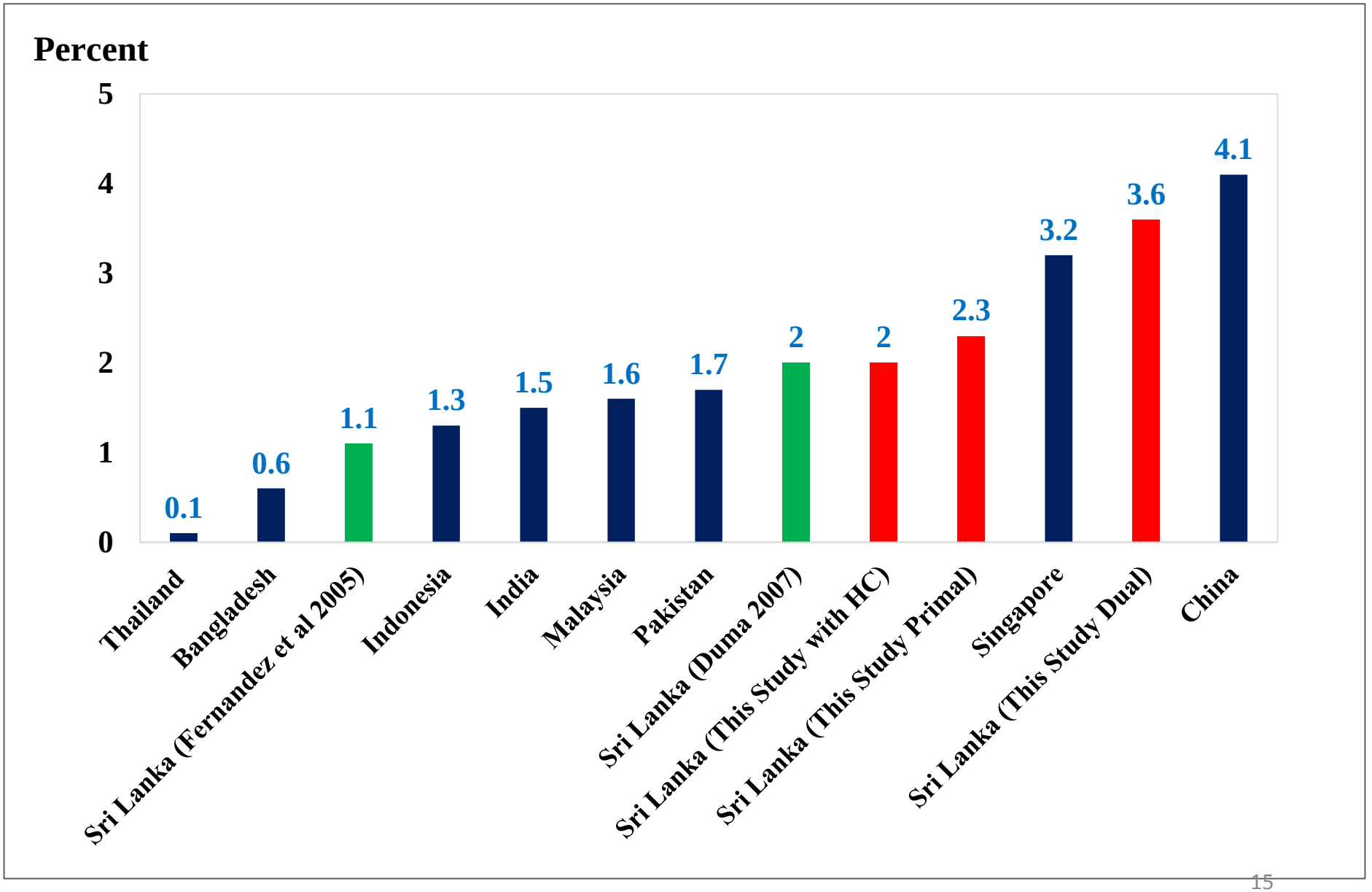
3. A cross country TFPG comparison

4. Conduct a sensitivity analysis

6. Extensions - Comparison of Alternative TFPG Estimates with PWT 9.0



6. Extensions - Cross Country TFPG Comparison



6. Extensions - Sensitivity Analysis

Period	Baseline	S 1	S 2	S 3
		Higher δ	Medium δ	Higher α
	α=0.3	α=0.3	α=0.3	α=0.4
		δ (%)		
Before 1980s	6.7	6.7	8	6.7
1980-2009	10	25	8	10
After 2009	6.7	6.7	8	6.7
TFPG (%)	2.3	2.4	2.2	1.7

α - Sensitive **δ – Non-sensitive**

Answering Research Questions

	Research Questions	Findings
1	TFPG for Sri Lanka under both approaches (1980-2016)	Primal: 2.3% Dual: 3.6%
2	TFPG's contribution for the GDP growth in Sri Lanka	45%
3	Reasons for the differences in estimates under both approaches	Issues in national account estimates Market imperfections
4	TFPG's sensitivity to the assumptions on factor shares and depreciation rates	α - Sensitive δ – Non-sensitive
5	Sri Lanka's TFPG in comparison to peers	Higher than other countries in the region except in China and Singapore

7. Conclusions

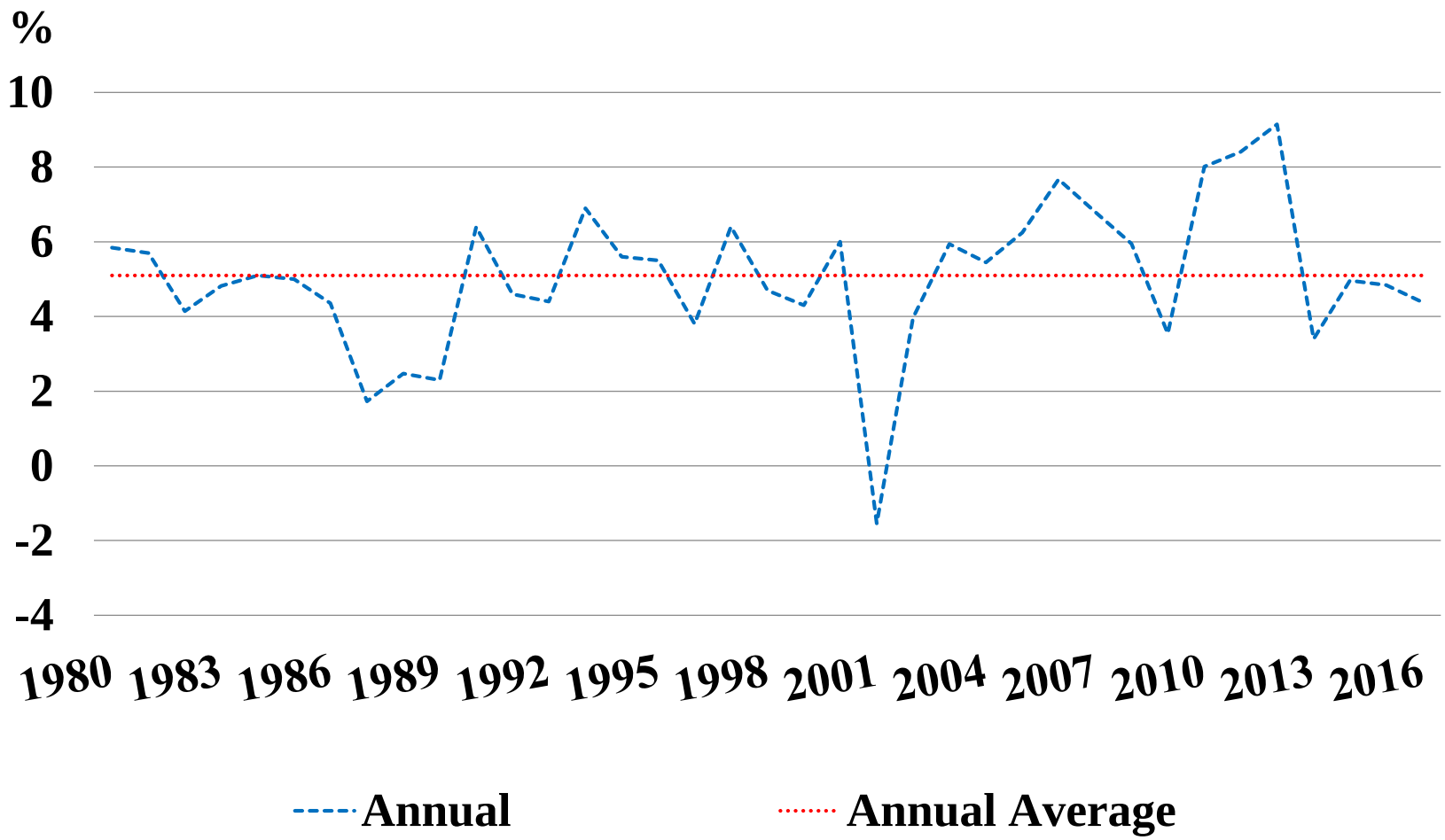
1. Sri Lanka's growth has been driven by both productivity and capital accumulation

2. Relative importance of productivity and factor accumulation in GDP growth has alternatively changed over time

Thank You!

Annex

GDP Growth in Sri Lanka 1980-2016



Reasons for TFPG Behaviour

Period	TFPG	Reasons
1980-1984	1.7	1980-84, capital was the main contributor to growth. This was because immediately after the opening of the economy in late 1977, there was a massive capital inflow to the country via concessionary loans and in some cases, foreign capital grants, to undertake important hydroelectricity cum irrigation projects
1985-1989	0.8	from 1985 to 1989 country was afflicted with two internal conflicts lading to low economic growth resulting to decline in TFPG
1990-1994	4.3	During 1990-94 the government of the day started a special industrial project by promoting textiles and garment industry through 200 such factories catering to the Western developed nations. Consequently, growth accelerated to 5.6 percent the result was the acceleration of TFPG to 4.3 percent, the highest ever during all the sub periods under consideration. This accounted for 77 percent of the output growth during this sub period
1995-1999	2.0	During 1995-1999, Sri Lanka faced with many acts of large scale violence, including the bombing of the Central Bank. Consequently, economic growth decelerated to 4.9 percent forcing TFPG to fall to 2 percent.
2000-2004	-0.2	GDP growth further declined to 4 percent during 2000-2004, with the escalation of violence at the beginning of the period and unfavourable global situation specifically in 2001. Country first time in the history reported a negative economic growth of 1.5 percent in 2001. TFPG amounted to negative 0.2 percent in this period
2005-2009	3.7	In 2005-2009 though war was there country was able to attain a higher economic growth of 6 percent amidst some external shocks such as increases in energy prices in the global markets. That high economic growth which basically came from high investment in capital projects resulted in improving the TFPG to 3.7 percent.
2010-2014	3.8	From 2010 to 2014 in which peace prevailed in Sri Lanka, economic growth further accelerated to 6.8 percent improving TFPG to 3.8 percent mainly due to government‘ investment in the infrastructure.
2015-2016	1.0	During 2015-2016, Sri Lanka failed to harness its growth potential, mainly due to over-concentrating on political reforms thereby ignoring the needed economic reforms by the new government. The lack of economic reforms was the major obstacle for continued sustained economic growth in the country. That led to contraction of economic growth to 4.6 resulting to TFPG of 1 percent

Primal and Dual Approaches

• Under **primal approach**, scholars had applied the theoretical foundation of production function introduced by Solow (1967) to derive TFPG as the residual after deducting the growth of the factors of production from the GDP growth assuming the existence of a competitive market and Constant Return to Scale

• Alternatively, under **dual approach** TFPG is calculated using the application of the national income identity along with data on factor prices assuming that there are no market imperfections.

Perpetuity Inventory Model – Capital Stock

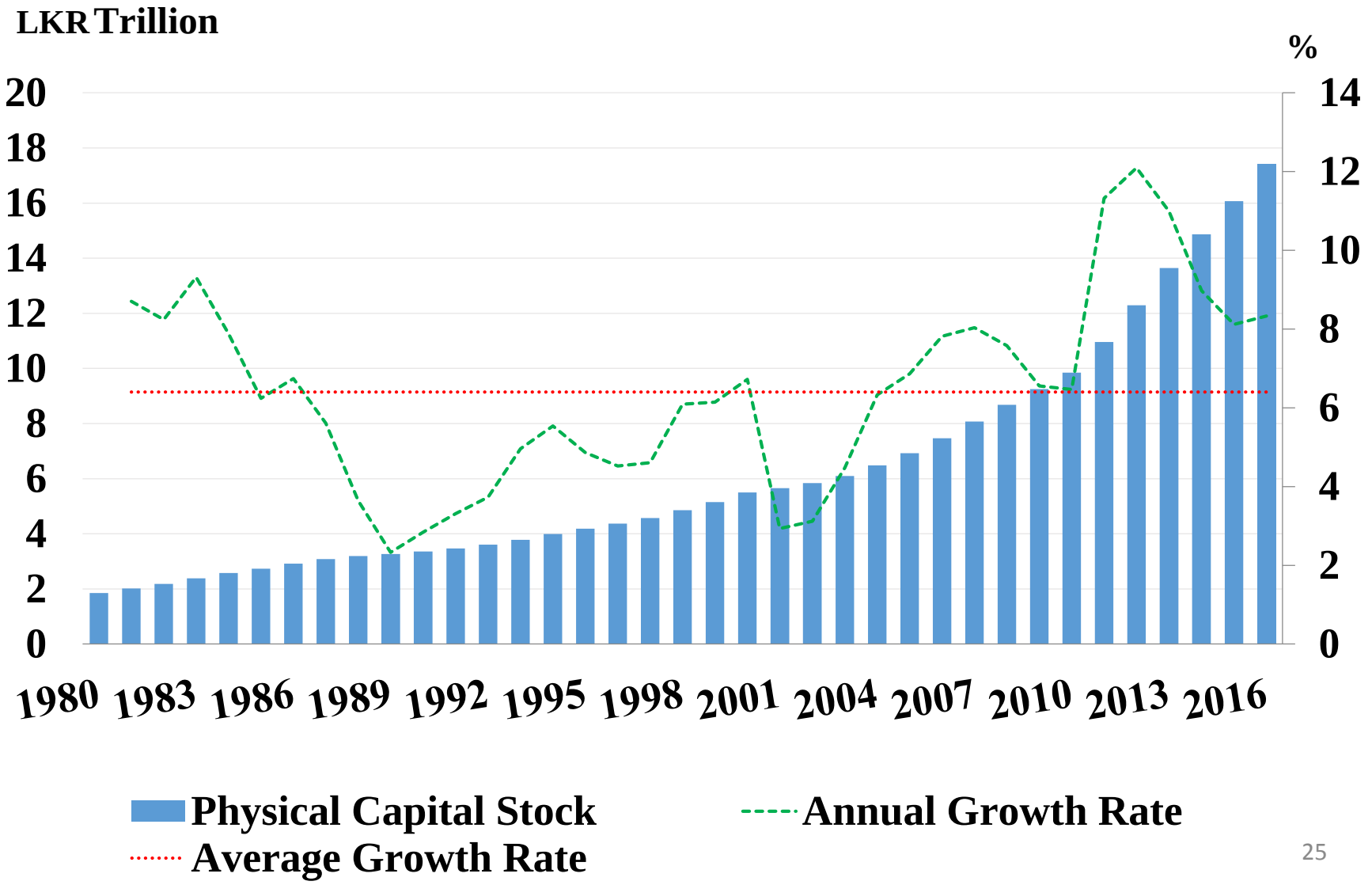
$$K_t = (1 - \delta)K_{t-1} + I_t$$

where K_t is the physical capital stock at time t, δ is the depreciation rate of capital and I_t is investment at time t. Accordingly, capital stock in the current year is equal to the previous year's capital stock adjusted for depreciation plus investments in the current year.

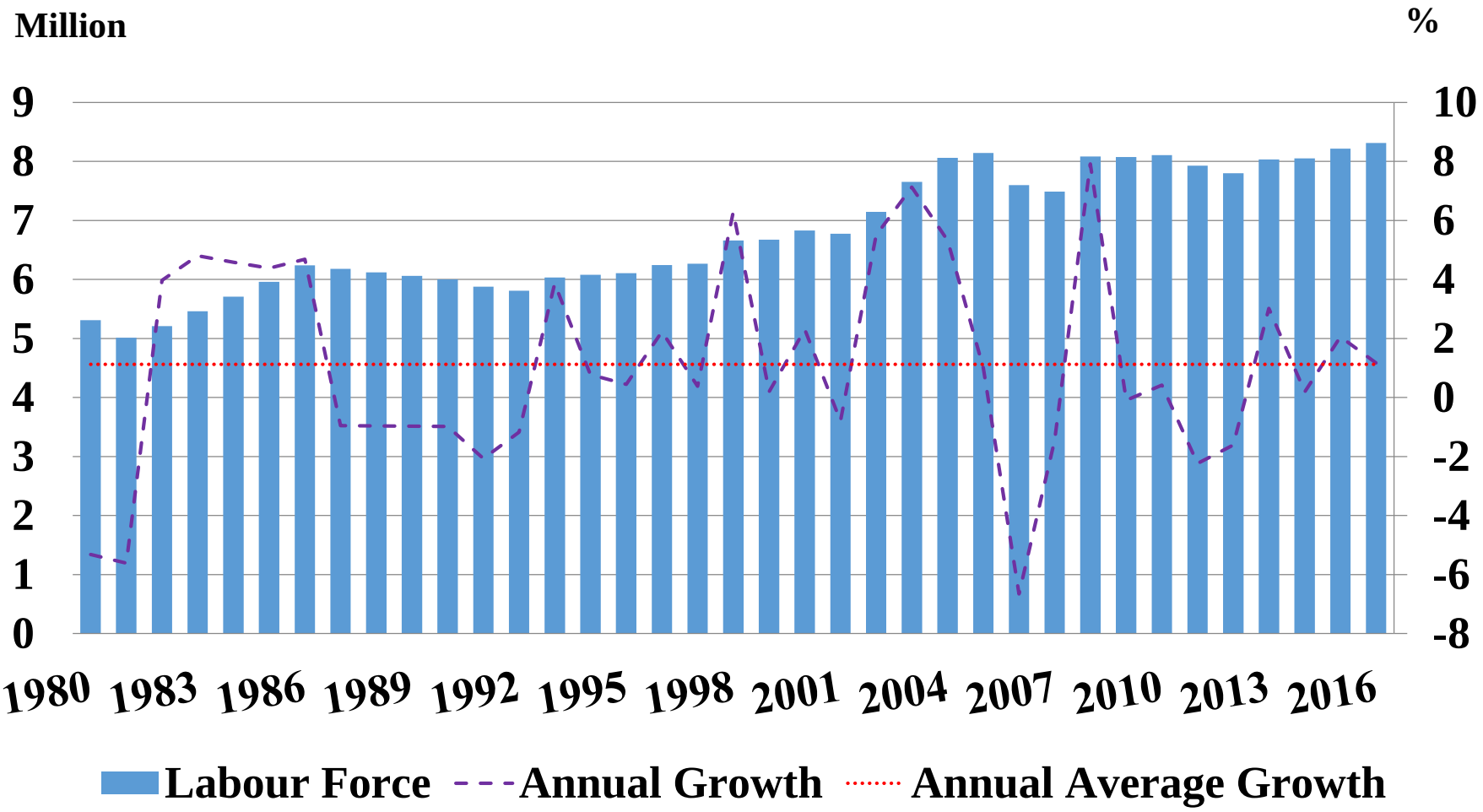
$$K_{t-1} = \frac{I_t}{g +}$$

where I_t is the current year investment, g is long-term annual average output growth and δ is the depreciation rate. When the economy is in equilibrium, the capital stock in the initial period can be calculated using data on current level of investments, depreciation rate and the growth rate of output.

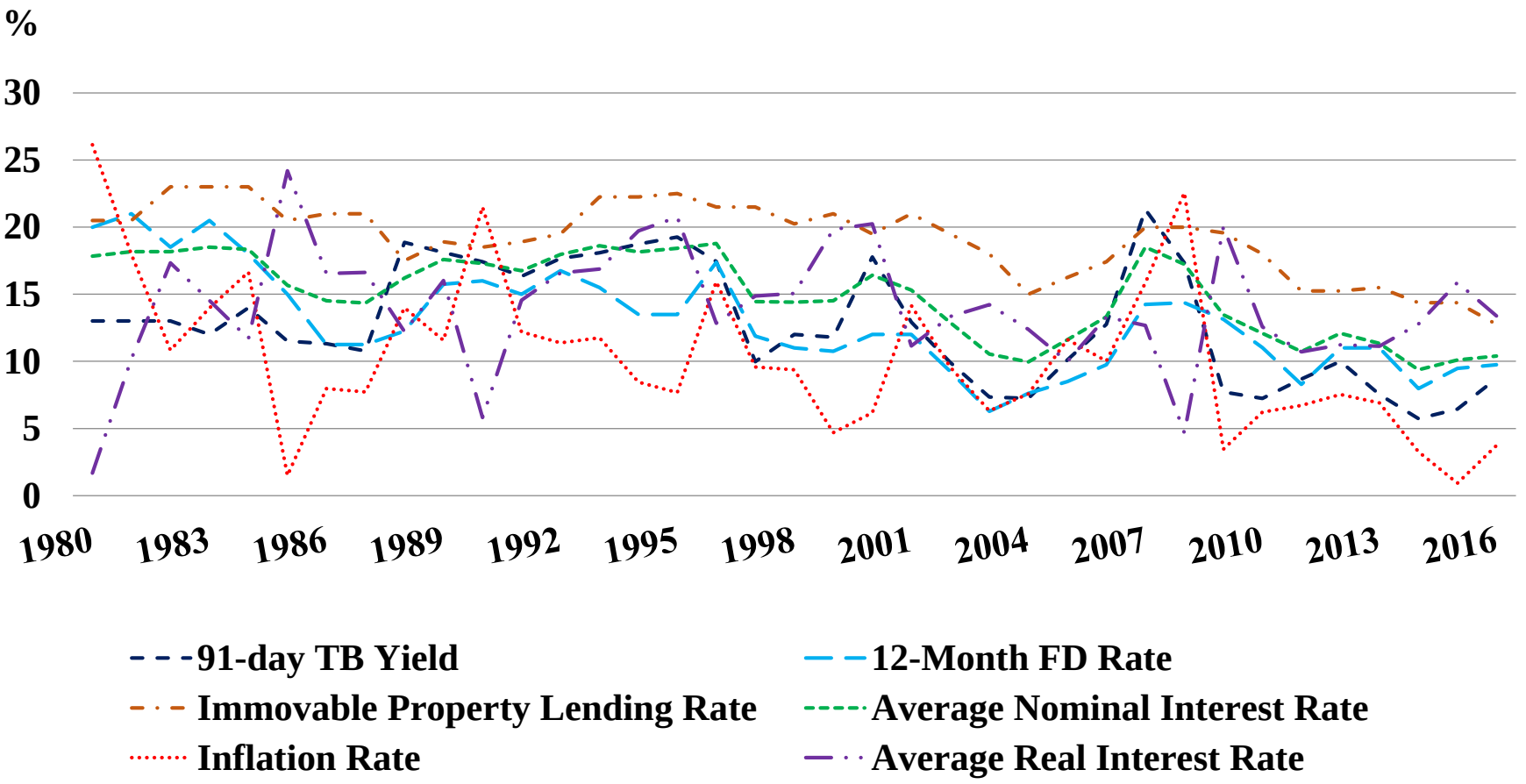
Physical Capital Stock and its Growth 1980 - 2016



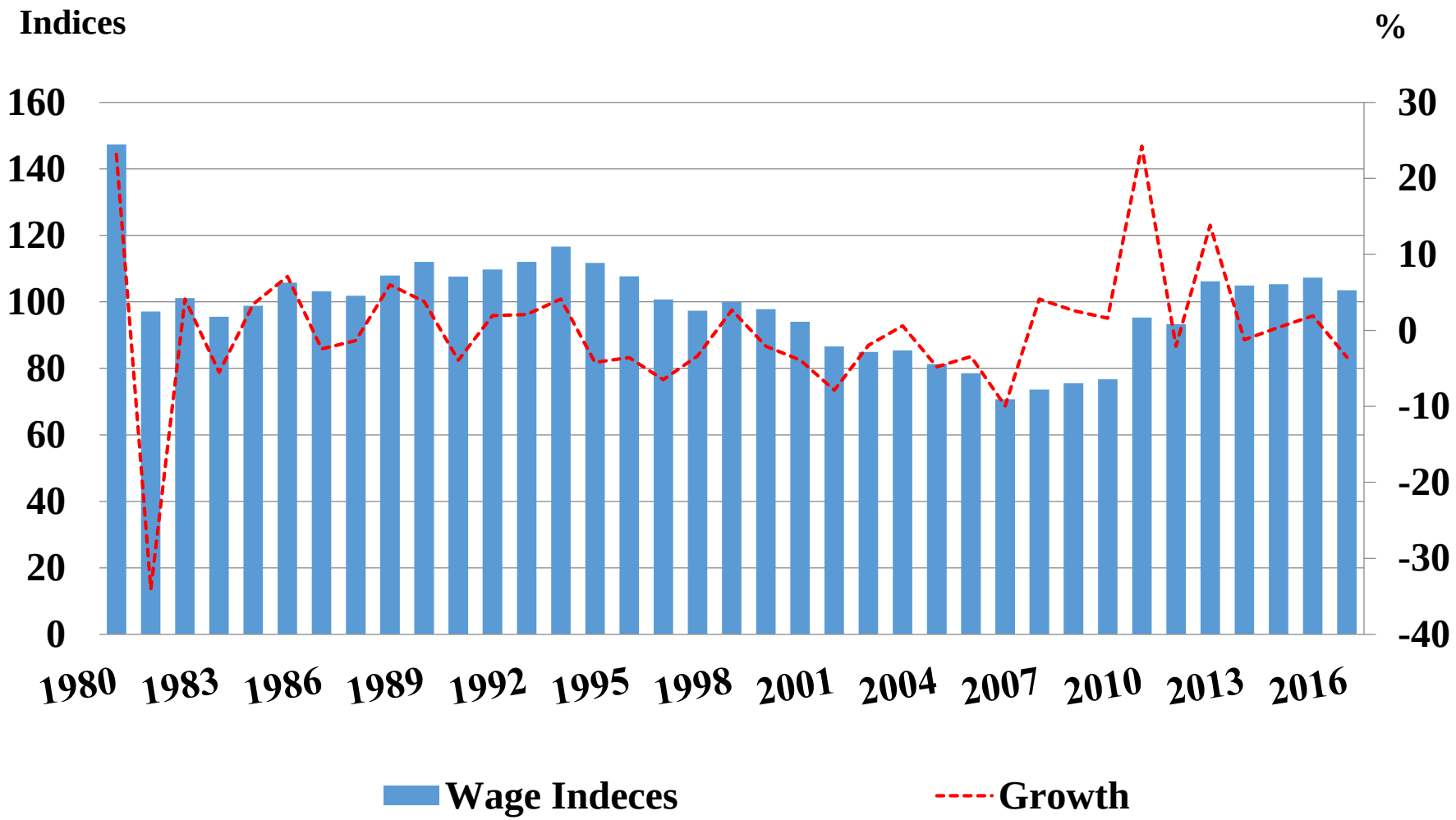
Labour Force and its Growth 1980 - 2016



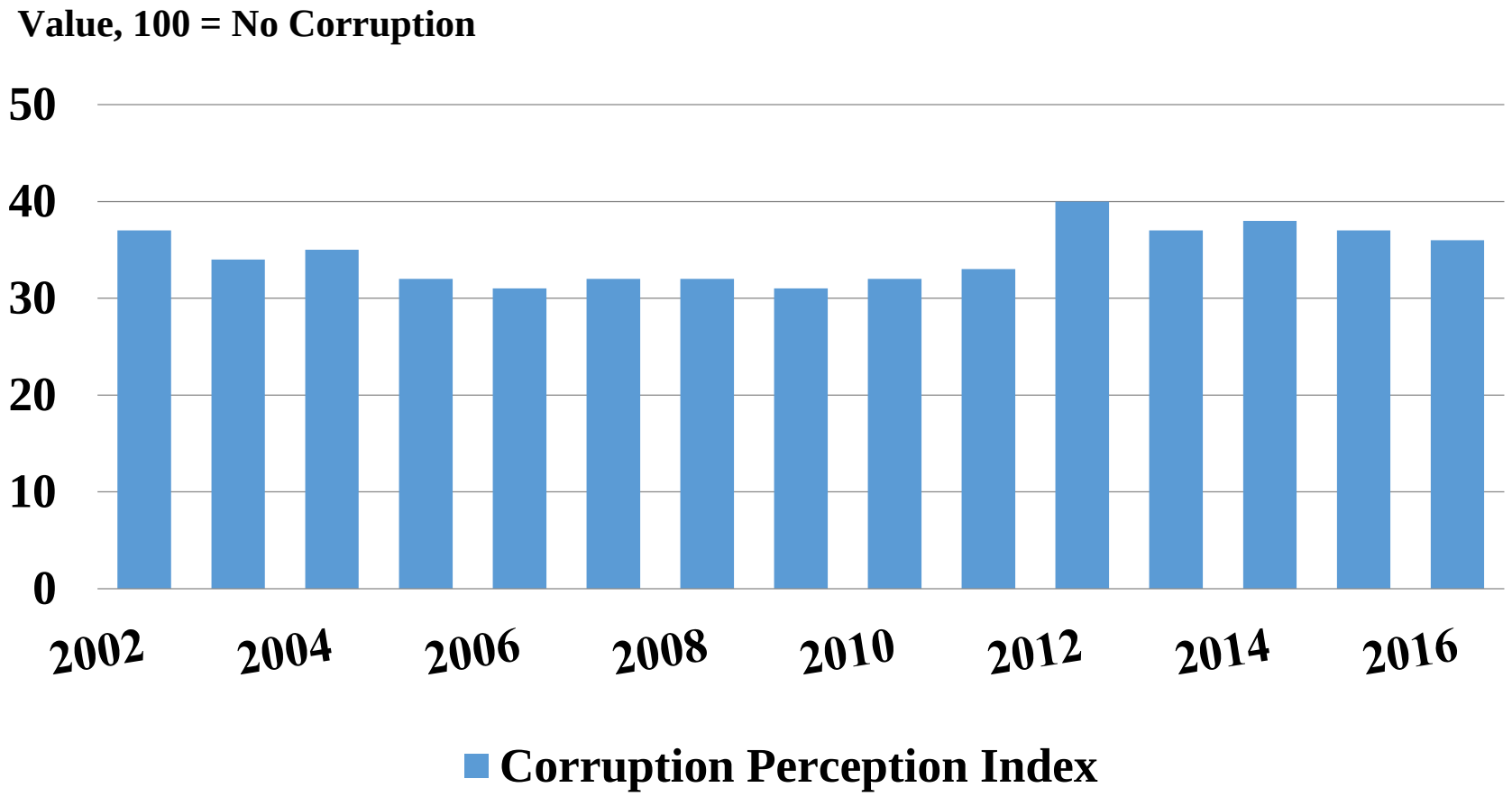
Movement of Interest Rates and Inflation 1980-2016



Evolution of Real Wage Rate Indices



Sri Lanka's Corruption Perception Index 2002 to 2016



Comparison of TFPG with the Related Literature

Period	Baseline Primal	Primal with HC	Duma	PWT
1980-1989	0.9	1.3	0.5	0.0
1990-1999	2.4	1.5	2.9	2.6
2000-2005	0.2	0.4	2.7	1.1
2003-2006	3.2	3.2	3.1	2.7
1980-2006	1.6	2.0	2.0	1.4