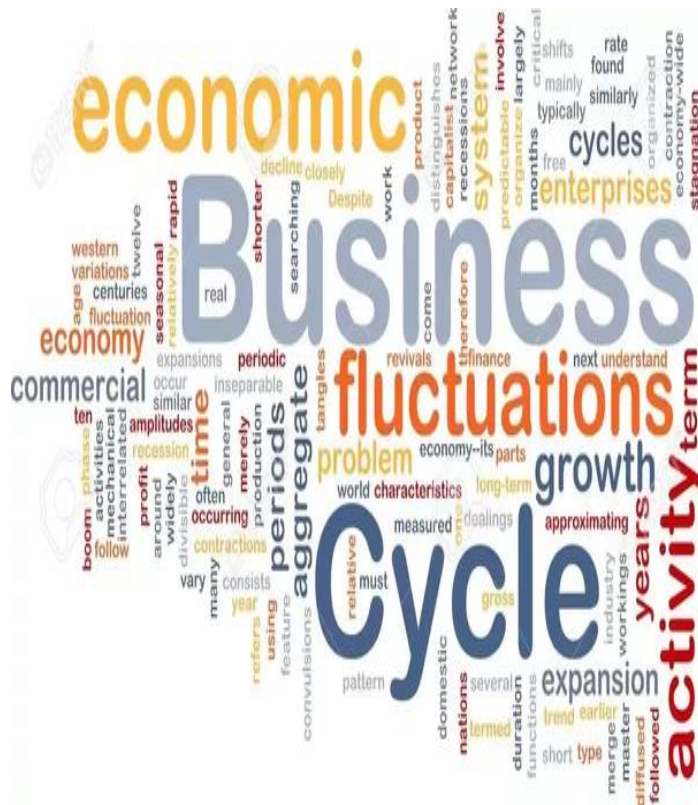


INTERMEDIATE MACROECONOMICS

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AGENDA



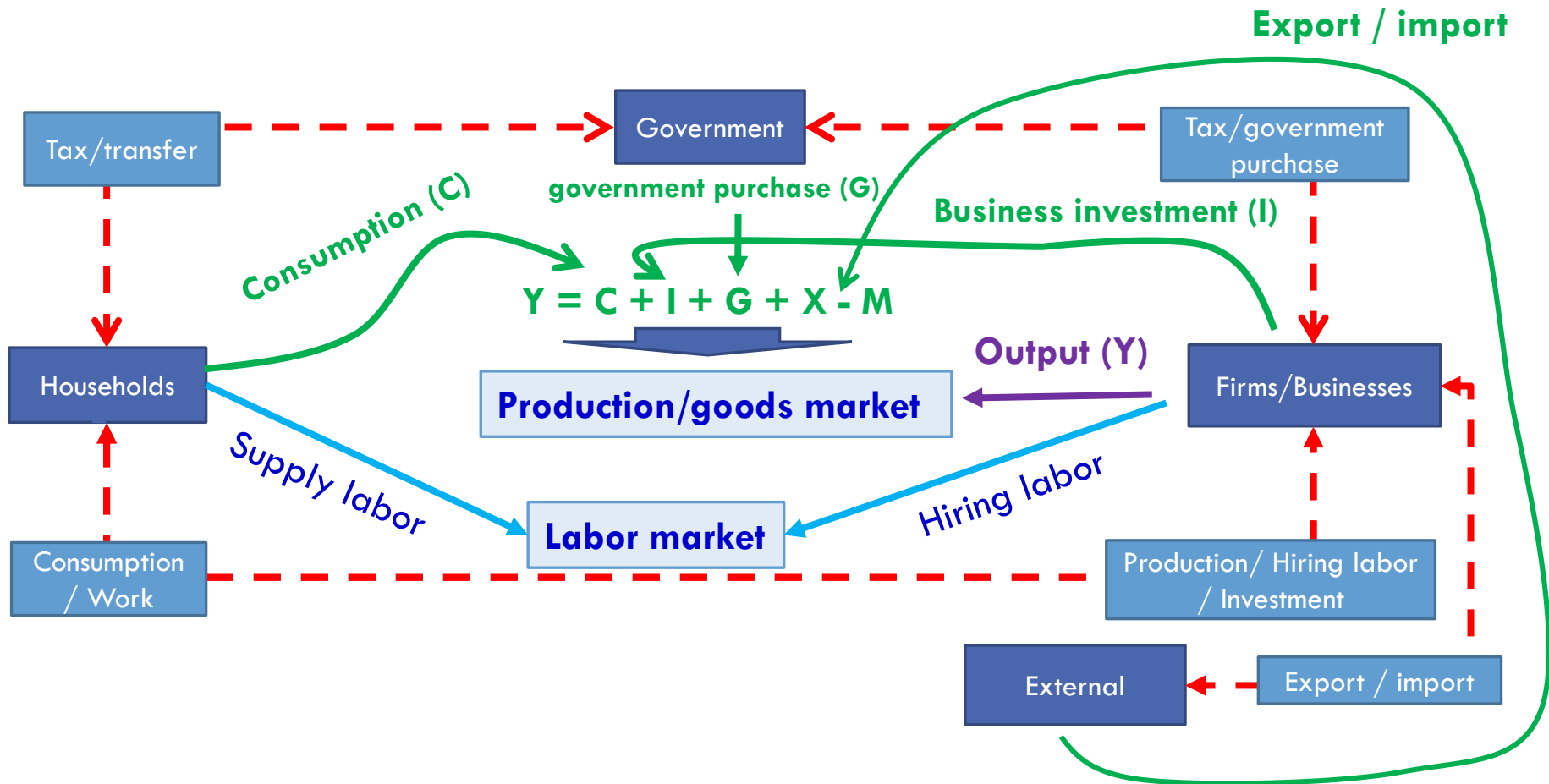
- A helicopter tour on the macroeconomy and key economic indicators
- Measuring business cycles
- Business cycle models: aims and ingredients

Helicopter tour and indicators		Measuring business cycles		Business cycles model	
Production	Prices	Labor	Financial	External	

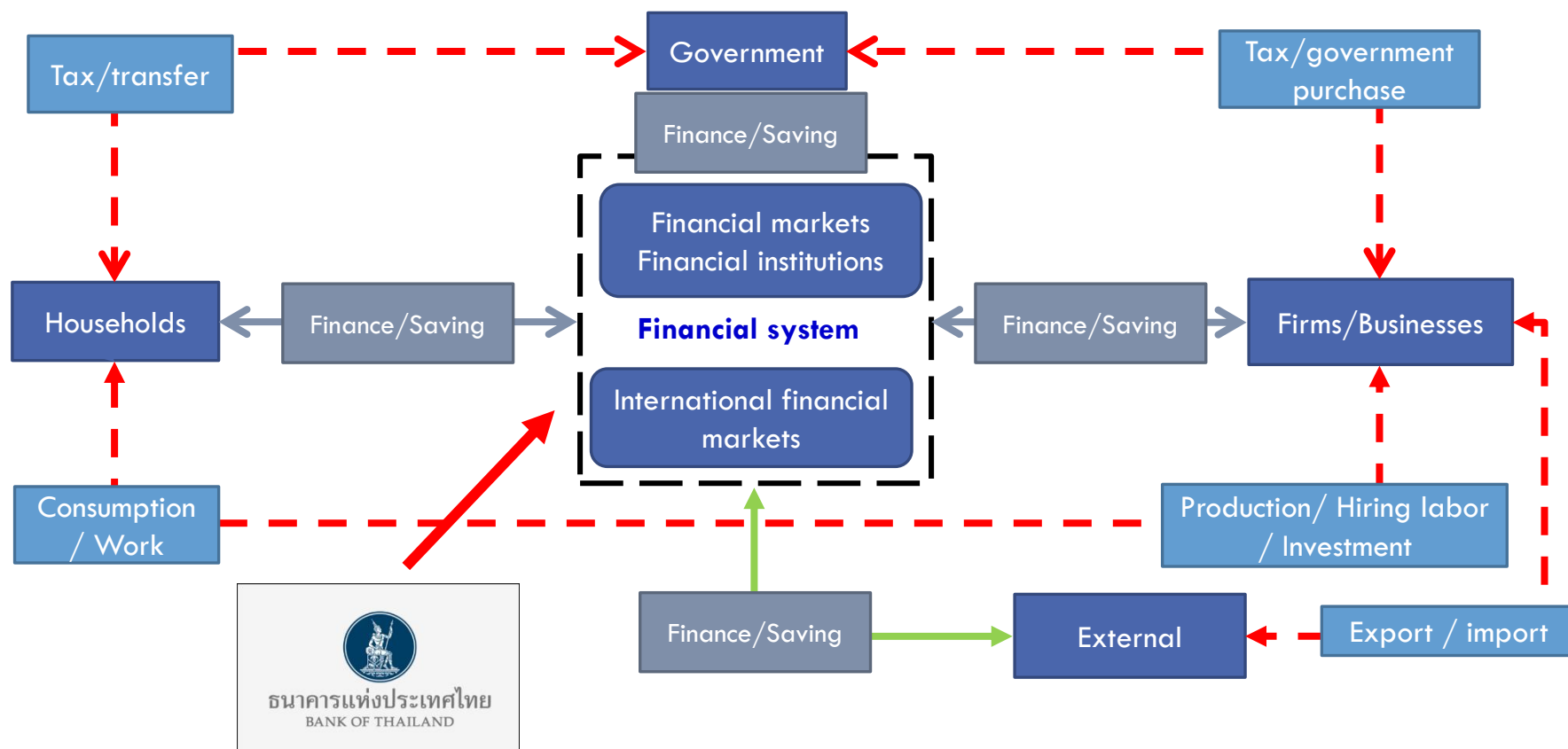
A HELICOPTER TOUR ON THE STRUCTURE OF MACROECONOMY

- Macroeconomics is about studying the **interlinkage** among different **players/ segmented markets/** in the economy.
 - **Players:** Firms, households, business sector, governments, ROTW etc...
 - **Segmented markets:** production/goods, labor, international, financial and capital markets, etc...

DIAGRAMMATIC REPRESENTATION OF THE INTERCONNECTIONS IN MACROECONOMY: MARKETS AND PLAYERS



DIAGRAMMATIC REPRESENTATION OF THE INTERCONNECTIONS IN MACROECONOMY



Helicopter tour and indicators		Measuring business cycles		Business cycles model	
Production	Prices	Labor	Financial	External	

DIAGRAMMATIC REPRESENTATION OF INTERCONNECTION IN MACROECONOMY

- The outcome that emerged from their interaction can be represented in terms of **macroeconomic data**.
- Contains millions of datasets; **let's group them by markets**
 - Production and real economic activities
 - Prices
 - Labor indicators
 - Financial and monetary variables
 - External

Helicopter tour and indicators		Measuring business cycles		Business cycles model	
Production	Prices	Labor	Financial	External	

REAL ECONOMIC ACTIVATES

- “Real” Production “activities” → commonly referred to **“NIPA accounts”**
 - Highly aggregate one is the concept of current market value GDP
 - Three different **bottom-up approaches**: Income, **Production (value-added)**, **Expenditure**.
- In Thailand, the statistical agency that is responsible for measuring and producing data for these aggregate activities is **NESDB** (สภาพัฒน์ฯ).
 - Starting from 1993, NESDB has made the data available in **quarterly** basis. (why?)
 - Reporting statistic has some lagged periods of the announcement for 1.5 months.

DEEPER LOOK INTO THAI DATA: PRODUCTION-BASED *NOMINAL* GDP

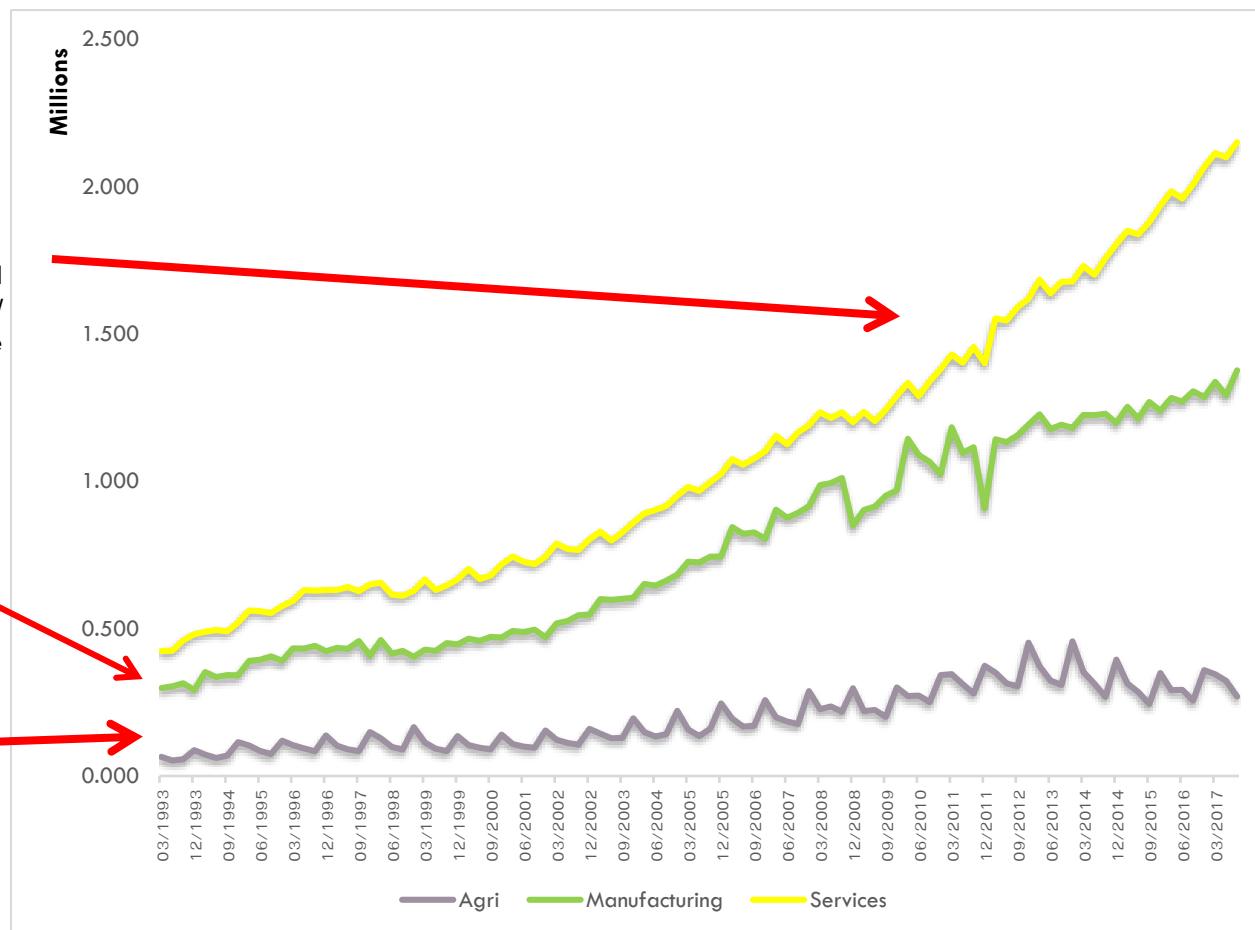
Services

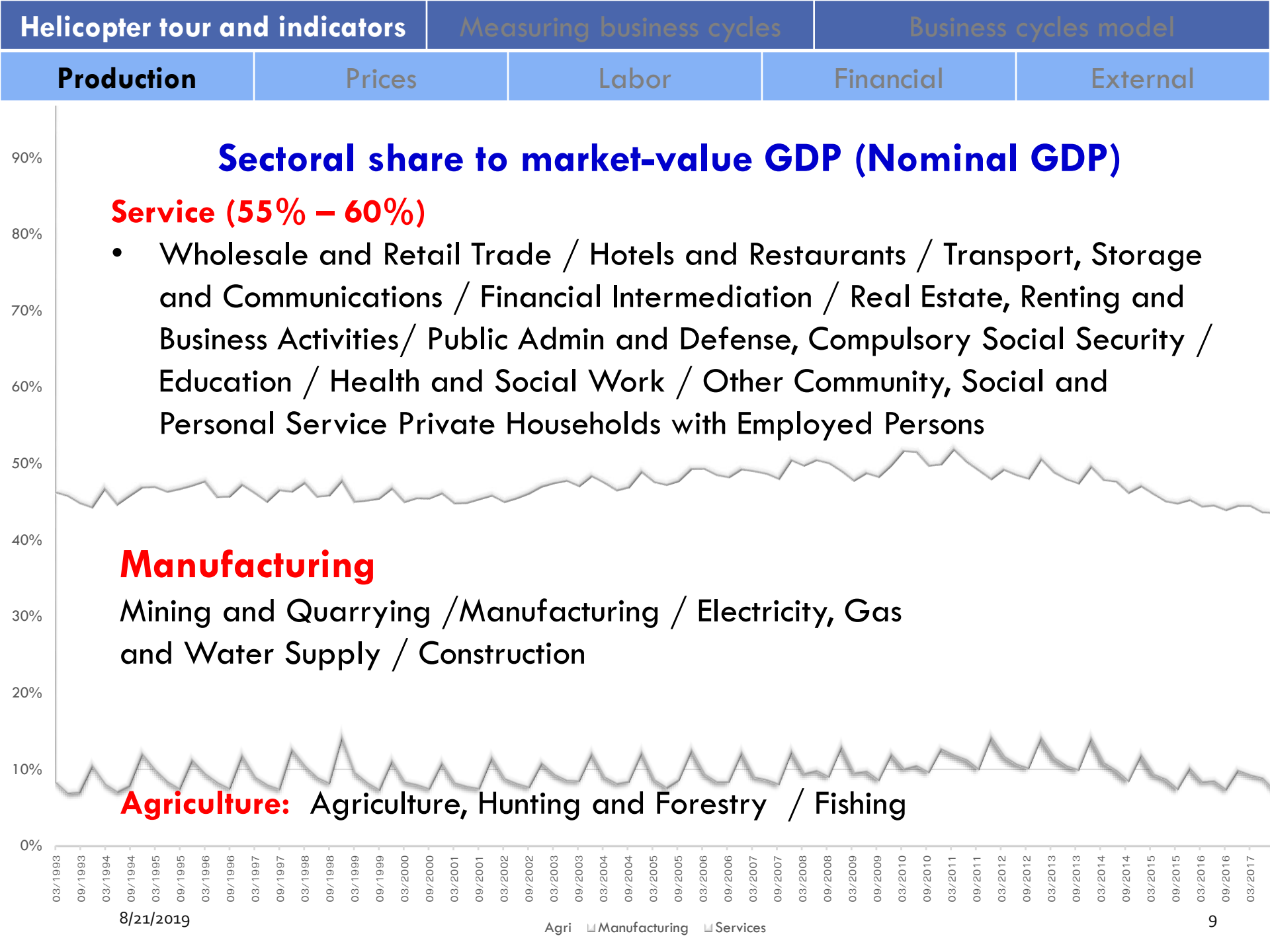
Wholesale and Retail Trade / Hotels and Restaurants / Transport, Storage and Communications / Financial Intermediation / Real Estate, Renting and Business Activities / Public Admin and Defense, Compulsory Social Security / Education / Health and Social Work / Other Community, Social and Personal Service
Private Households with Employed Persons

Manufacturing

Mining and Quarrying / Manufacturing / Electricity, Gas and Water Supply / Construction

Agricultural

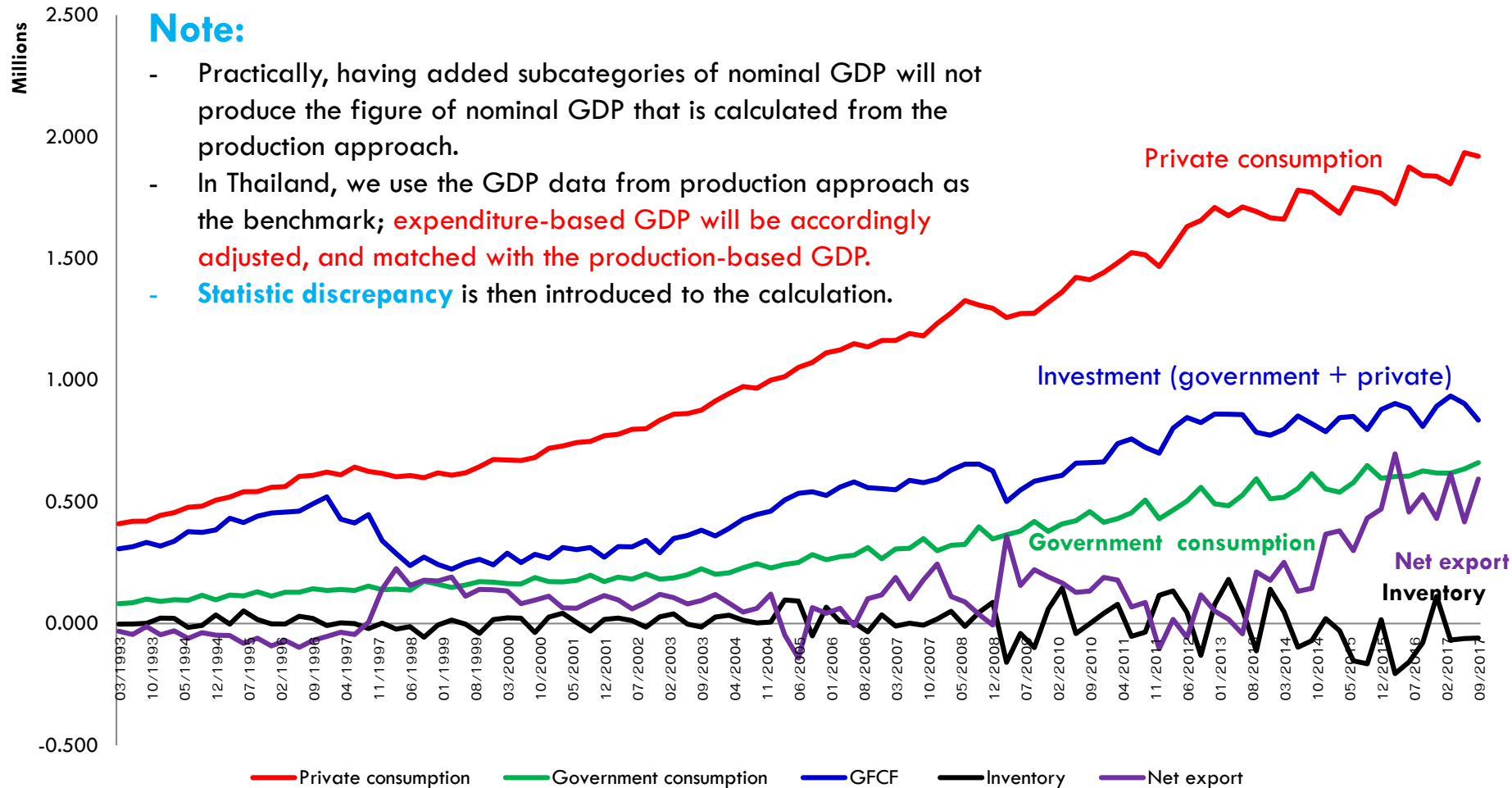




EXPENDITURE-BASED GDP: ITS NOMINAL COMPONENT

Note:

- Practically, having added subcategories of nominal GDP will not produce the figure of nominal GDP that is calculated from the production approach.
- In Thailand, we use the GDP data from production approach as the benchmark; **expenditure-based GDP will be accordingly adjusted, and matched with the production-based GDP.**
- **Statistic discrepancy** is then introduced to the calculation.



Helicopter tour and indicators		Measuring business cycles		Business cycles model	
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PROBLEM WITH THE MARKET VALUE MEASUREMENT

- Misleading about the **true state of production**
 - Market value = $P * Q$; Growing because of higher price
- Idea: **eliminate the price effect (extract the volume effect or real quantity)**
- Proposal: One simple method is to calculate the value output **using prices in a fixed base year**.

Helicopter tour and indicators		Measuring business cycles		Business cycles model	
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REAL GDP: FIXED BASE YEAR

- Real GDP is obtained by **using based-year prices** in calculation.
 - For example, assume the base year = 1988

$$rGDP^{2018} = \sum_i (P_i^{1988} * Q_i^{2018})$$

$$rGDP^{2017} = \sum_i (P_i^{1988} * Q_i^{2017})$$

$$g^{2018} = \left[\frac{rGDP^{2018}}{rGDP^{2017}} - 1 \right] * 100\%$$

With this method, the growing economy is due to the quantity effect, but not due to the price.

PROBLEM WITH THE FIXED BASE YEAR

- Main problem: **fixed base years do not reflect economic changes over time.**
 - Changes in the composition of output and relative prices. (USB in 1998 / USB in 2018)
 - Improved quality of existing products.
 - New goods come to markets; old goods die out.



Helicopter tour and indicators		Measuring business cycles		Business cycles model	
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PROBLEM WITH THE FIXED BASE YEAR → SOLUTION?

- An easy solution is to periodically change the base year.
 - In Thailand, we have been changing the base year for several times: 1956 1962 1972 1988.
- However, updating fixed-base year revises not only historical series of real GDP, but also the entire historical path of growth rate.
- Modern approach recommends the calculation using the **Chained-volume measure GDP, e.g. CVM-GDP.**

Helicopter tour and indicators		Measuring business cycles		Business cycles model	
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CHAINED-VOLUME MEASURE GDP

- The method is to continuously rebase the year prices used in the calculation.
 - Very technical idea
 - Define CI_t as cumulative growth index t-period from the reference period

$$CI_t = \frac{\sum P_0 Q_1}{\sum P_0 Q_0} * \frac{\sum P_1 Q_2}{\sum P_1 Q_1} * \frac{\sum P_2 Q_3}{\sum P_2 Q_2} * \dots * \frac{\sum P_{t-1} Q_t}{\sum P_{t-1} Q_{t-1}} \times 100$$

$$cvmRGDP_t = \sum P_0 Q_0 * (CI_t)$$

CVM GDP: EXAMPLE

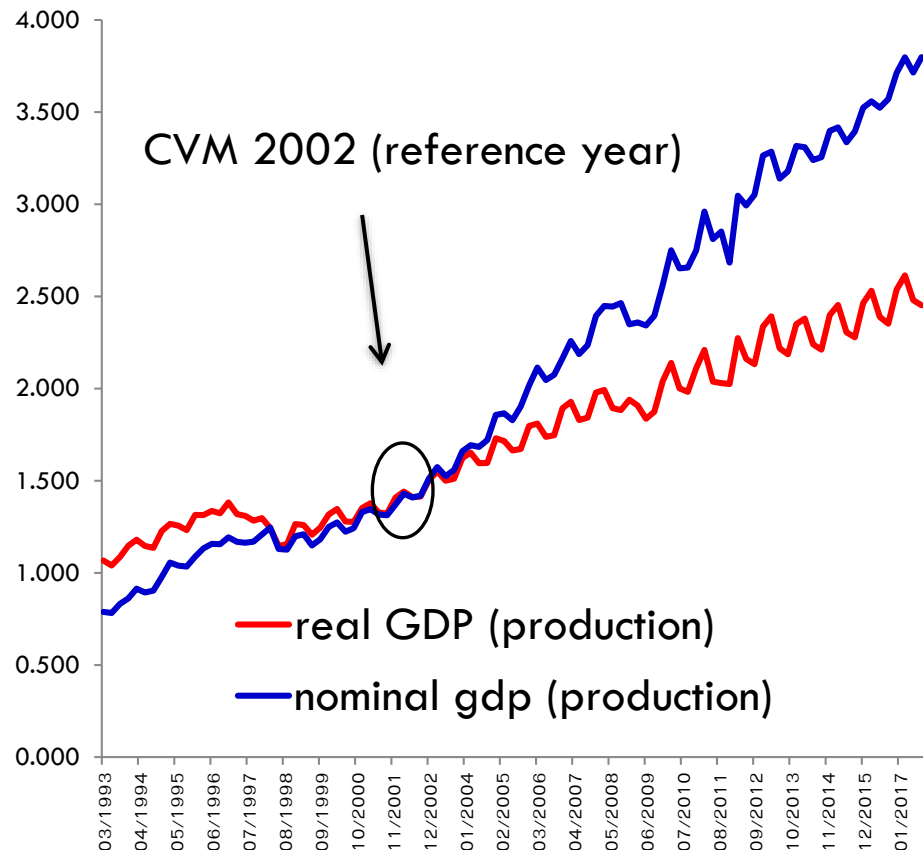


	Period 0.....			Period 1.....				Period 2.....			
Commodity	Price (P_0)	Quantity (Q_0)	Current price estimate of value (P_0Q_0)	Price (P_1)	Quantity (Q_1)	Current price estimate of value (P_1Q_1)	Chain volume estimate	Price (P_2)	Quantity (Q_2)	Current price estimate of value (P_2Q_2)	Chain volume estimate
Apples	\$1	5	\$5	\$2	8	\$16	\$8	\$3	13	\$39	\$13
Oranges	\$3	3	\$9	\$4	5	\$20	\$15	\$5	10	\$50	\$30
Total (current prices)			\$14			\$36				\$89	
Total (chain volume estimate) (a)							\$23				\$42.17
Chain volume index number			100.0				164.3				301.2

(a) Chain volume index referenced to Period 0 current price estimate.



REAL V.S. NOMINAL GDP MEASUREMENT



- CVM series are **non-additive**.
 - For the reference year, GDP subcategories sum up to total GDP.
- For other years, subcategories do not sum up.

$$RGDP \neq RGDP_SERVICE + RGDP_MANU + RGDP_AGRI$$

$$RGDP \neq RPC + RPI + RG + RX - RM$$

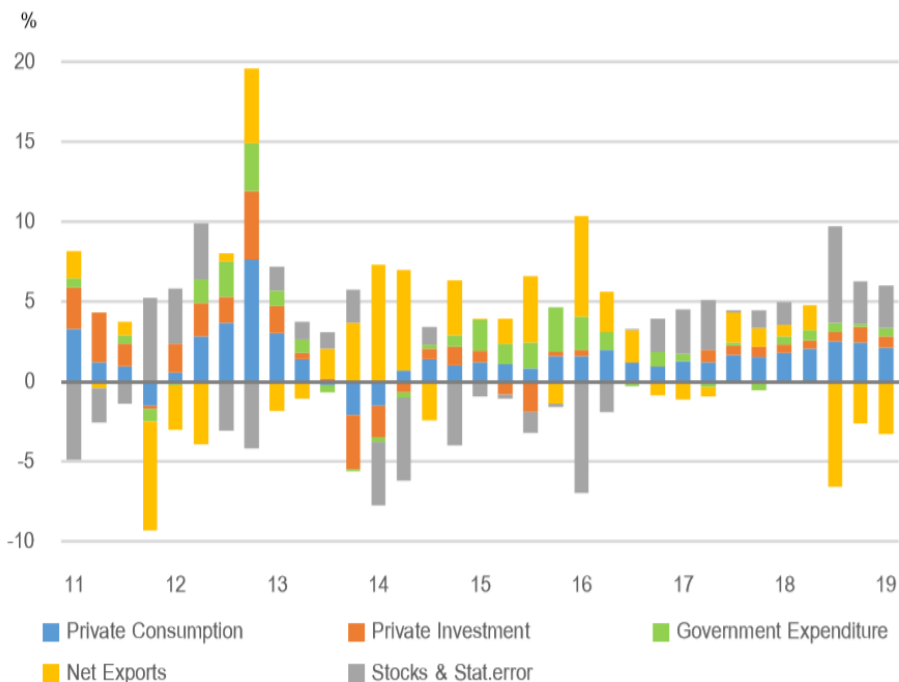
- In terms of accounting, this is technically adjusted by “**residual terms**”.

CVM GDP IN THAILAND

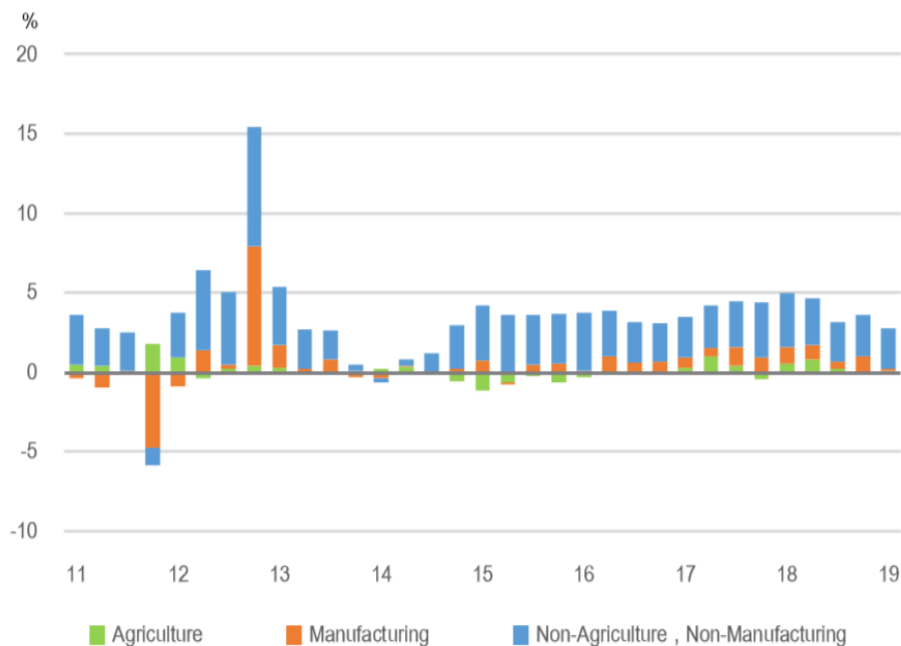
$$Y = x_1 + x_2 + x_3 + \dots + x_N \rightarrow \% \Delta Y = \frac{x_1}{Y} \% \Delta x_1 + \frac{x_2}{Y} \% \Delta x_2 + \frac{x_3}{Y} \% \Delta x_3 + \dots + \frac{x_N}{Y} \% \Delta x_N$$

$\frac{x_1}{Y} \% \Delta x_1$ = contribution of x_1 to growth in Y (fraction of growth in Y explained by factor x_1)

Contribution to GDP Expenditure [Q]



Contribution to GDP Production [Q]



Source: Office of the National Economic and Social Development Board,
8/21/2019
calculated by Bank of Thailand

Source: Office of the National Economic and Social Development Board,
calculated by Bank of Thailand

Helicopter tour and indicators		Measuring business cycles		Business cycles model	
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PRICES

- At the aggregate level, we refer to the measurement of **overall prices of goods and services**
 - Cheap / expensive → overall cost of production / overall cost of living
- Problem: Million items → Million prices...how to measure the overall price then
- **Construct price index!**

Helicopter tour and indicators		Measuring business cycles		Business cycles model	
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WHAT IS AN INDEX NUMBER?

- In general, an **index number** is an economic figure reflecting “**price or quantity**” compared with **a base value reported in a given year**.
 - e.g. SET index, Industrial production index etc.
- To construction an index, we need “**individual data**” and “**base value**” for comparison.
- In practice, most index numbers would set its value equal to 100 in the base year, and basically take the form,

$$X_t = \sum_{i=1}^N w_{i,t} * x_{i,t} \times 100$$

Helicopter tour and indicators		Measuring business cycles		Business cycles model	
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IMPLICIT GDP PRICE DEFLATOR INDEX

- The ratio of the nominal GDP to the real GDP of a given year.
- The most **comprehensive** *price index*.
 - includes prices of **all final goods and services**.

$$\text{Implicit GDP price deflator} = \frac{\text{Nominal GDP}}{\text{Real GDP}} * 100$$

Helicopter tour and indicators		Measuring business cycles		Business cycles model	
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IMPLICIT GDP PRICE DEFLATOR INDEX

- Note that

$$P_t = \frac{\text{Nominal}}{\text{Real}} \times 100 = \frac{\sum_{i=1}^N P_{i,t} Q_{i,t}}{\sum_{i=1}^N P_{i,0} Q_{i,t}} \times 100 = \sum_{i=1}^N \frac{P_{i,t} \left(\frac{P_{i,0}}{P_{0,t}} \right) Q_{i,t}}{\sum_{i=1}^N P_{0,t} Q_{i,t}} \times 100$$

$$= \sum_{i=1}^N \frac{P_{i,0} Q_{i,t}}{\sum_{i=1}^N P_{0,t} Q_{i,t}} \left(\frac{P_{i,t}}{P_{i,0}} \right) \times 100$$

$$X_t = \sum_{i=1}^N (\mathbf{w}_{i,t} * \mathbf{x}_{i,t}) \times 100$$

Helicopter tour and indicators		Measuring business cycles		Business cycles model	
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SOME OTHER IMPORTANT PRICE INDICES

- **Producer Price Index** : overall prices measured at the firm level
- **Consumer Price Index**: overall prices measured at the final purchase by households

Source: Bureau of Trade and Economic Indices.

- **Private consumption expenditure price index**: overall prices measured by using the private consumption data compiled in the NIPA

Source: NESDB.

Consumer Price Index: 2011=100
Consumer Price Index: 2011=100: Bangkok
Consumer Price Index: 2011=100: By Region
Consumer Price Index: 2011=100: Low Income
Consumer Price Index: 2011=100: Rural
Consumer Price Index: 2011=100: Weights
Producer Price Index: 1995=100: Classification of Production by Activities (CPA)
Producer Price Index: 1995=100: Stage of Processing (SOP)
Producer Price Index: 2000=100: Classification of Production by Activities (CPA)
Producer Price Index: 2000=100: Stage of Processing (SOP)
Producer Price Index: 2005=100: Classification of Production by Activities (CPA)
Producer Price Index: 2005=100: Stage of Processing (SOP)
Producer Price Index: 2010=100: Classification of Production by Activities (CPA)
Producer Price Index: 2010=100: Stage of Processing (SOP)
Rice Export Price
Sugar Export Price
Wholesale Price

Helicopter tour and indicators		Measuring business cycles		Business cycles model	
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CONSUMER PRICE INDEX

- **Cost of living index (COL):** how much expenditure would a typical household need to **ensure the same standard of living** as in the base year?
- **Consumer Price index:** **current-period expenditure** required by a typical household so that he/she can acquire **the same fixed basket of consumption goods as in the base year.**

CONSUMER PRICE INDEX: CONCEPTUAL METHOD

- The consumer price index (CPI) uses the current-year prices and **the base-year quantities of the goods**.
 - Base year = 2007; $CPI_{2007} = 100$

$$CPI_{2018} = \frac{\sum Q_{2007}^i P_{2012}^i}{\sum Q_{2007}^i P_{2007}^i} \times 100$$

$$CPI_{2018} = \sum \frac{Q_{2007}^i P_{2007}^i}{\sum Q_{2007}^i P_{2007}^i} \left(\frac{P_{2012}^i}{P_{2007}^i} \right) \times 100$$

- CPI inflation is % change in the CPI for any two consecutive periods.

$$CPI \text{ inflation}_{2018} = \frac{CPI_{2018}}{CPI_{2017}} \times 100$$

Helicopter tour and indicators		Measuring business cycles		Business cycles model	
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PROBLEMS WITH PRICE INDICES

- Changes in the quality of the goods over time.
- Emergence of new goods.
- Changes in the relative prices over time.
 - Assuming no change in consumers' choice despite changes in relative prices.
 - The items with rising prices will be over-weighted; **substitution biased**.

BIASED MEASUREMENT OF CPI INDEX

- The last problem leads to an over-estimation of COL.
- COL: **same standard of living?**
 - Same (original) bundle *or*
 - Same level of happiness.
- Following the latter, you can just substitute expensive items with cheaper ones.
 - Lower expenditure required then!

BIASED MEASUREMENT OF PRICE INDEX

- In the US, CPI inflation was found to be **approximately 1% over-estimate the true COL index.** (See Boskin 1996)
- Miscalculation matters a lot for public policy.
 - Social security payments are typically tied to inflation.
 - Upward biased calculation of COL generated in CPI inflation hence results in over-budgeting.

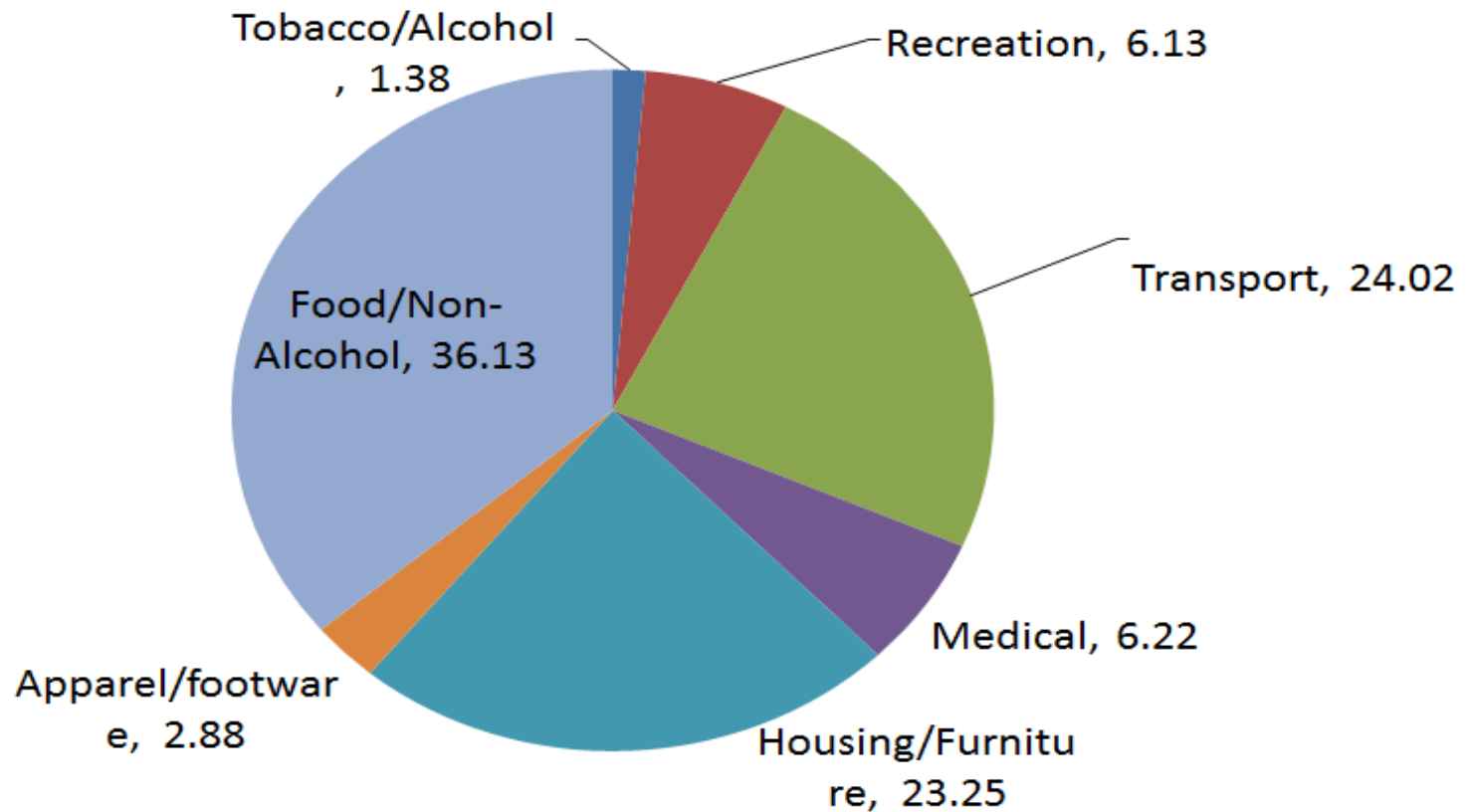
THAILAND'S INFLATION FIGURES

- The series are calculated monthly by the **Bureau of Trade and Economic Indices**, Internal Trade Department Ministry of Commerce (สำนักดัชนีเศรษฐกิจการค้า กรมการค้าภายใน)

- Data is collected on monthly basis, based on the survey.
 - **Headline (General) CPI**: prices of 7 groups (373 items) of goods and services.
 - **Core CPI**: prices of 266 items, excluding raw food and energy group (107 items; 27.40% based on overall weights for the whole kingdom).

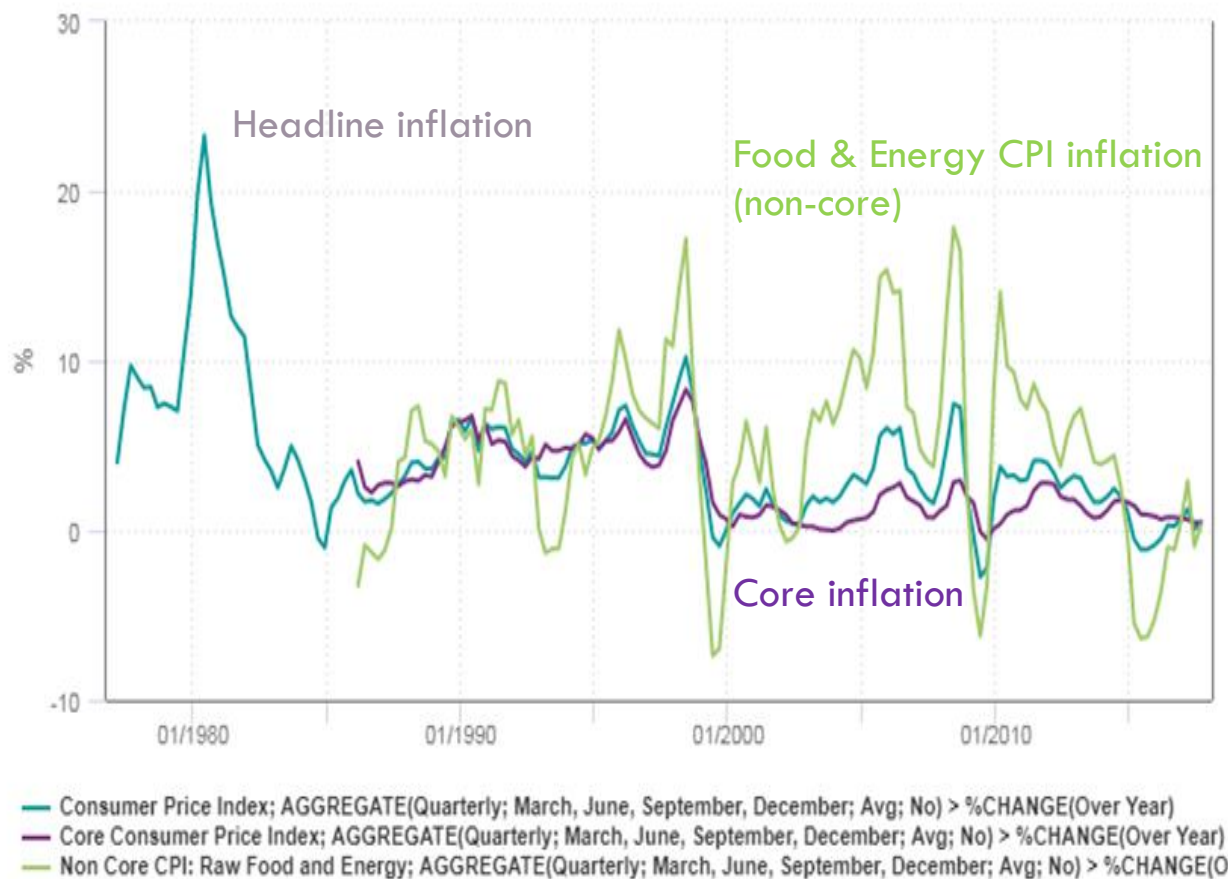
7 Components
1. Food and Beverages
2. Clothing
3. Housing
4. Healthcare
5. Transportation
6. Recreation and Education
7. Tobacco and Alcohol

WEIGHT IN THE CALCULATION OF CPI



HEADLINE AND CORE INFLATION

inflation measures



Source: CEIC Data

1. Core inflation appears to be more smooth than headline one.
2. Non-core component is highly fluctuate.
3. Central bank targets headline inflation; the band is [1%,4%]
4. In recent years, headline inflation has been off the target interval.

Helicopter tour and indicators		Measuring business cycles	Business cycles model	
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LABOR MARKET MEASUREMENT

- **Real GDP** provides us several key information on how strong economy is performing.
- **CPI Inflation** measures the rise of cost of living, and hence reflects welfare.
- Another counterpart measurement for the slackness/tightness economics activities is the labor market indicators such as *unemployment rate*.

Helicopter tour and indicators		Measuring business cycles		Business cycles model	
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HOW DO WE MEASURE LABOR MARKET ACTIVITIES

- Labor market indicators are reported by **survey (LFS)**.
- **Working-age population**: 15 years above, not incapacitate to work.
 - labor force plus + not in labor force.
- **Labor force** = the employed + unemployment.
- **Unemployment** = those who look for the job, but not currently being employed
- **Unemployment rate** = the unemployed/labor force.

THAILAND'S LABOR FORCE FIGURES

- Two sources: NESDB (and also NSO.)
- Labor force: persons with the age of 15-59.
- **Underemployment:** work less than 35 hours and available for more.

	2017/Q1
1.Population	67,555.03
1.1 Below 15 years	11,726.48
1.2 Above 15 years	55,828.55
2. Labor force (2.1 + 2.2 + 2.3) 3/	38,216.14
2.1 Employed	37,443.2
Underemployed	335.65
2.1.1.Agri	11,002.54
2.1.2.Manu	8,837.86
2.1.3 Service	14,689.65
2.2 Unemployment	463.38
2.3.seasonal unemployed	309.56
3.Not in the labor force with 15 years of age above	17,612.41
3.1 housework	5,169.94
3.2 study	4,444.33
3.3 Young / old / in capacitate to work	6,196.75
3.4 others	1,801.4
Labor force participation rate (2 divided by 1.2)	68.45%
unemployment rate (2.2 divided by 2)	1.21%

Helicopter tour and indicators		Measuring business cycles		Business cycles model	
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HOW DO WE MEASURE LABOR MARKET ACTIVITIES

- **Labor-force participation rate** = total labor force / working-age population
- **Discouraged workers:** those who wish to work but have stopped searching for jobs and thus are dropped out of the labor force.
- **Employment rate** = Employed person / working-age population

LABOR FORCE PARTICIPATION RATE

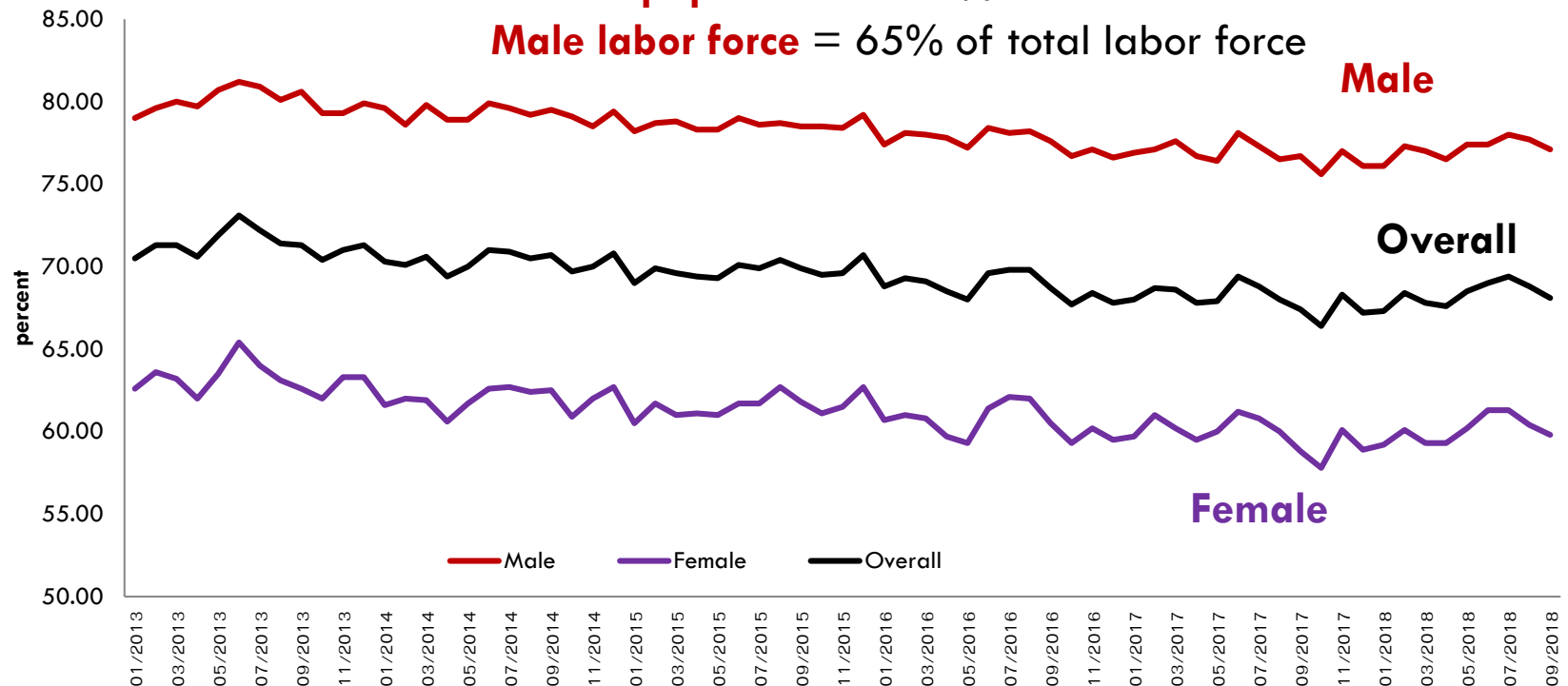
1. **Labor force participation** = Labor force / Pop > 15
2. Male participation rate is higher than that of female.

Labor force participation

Facts

Female pop > 15 = 51.6%

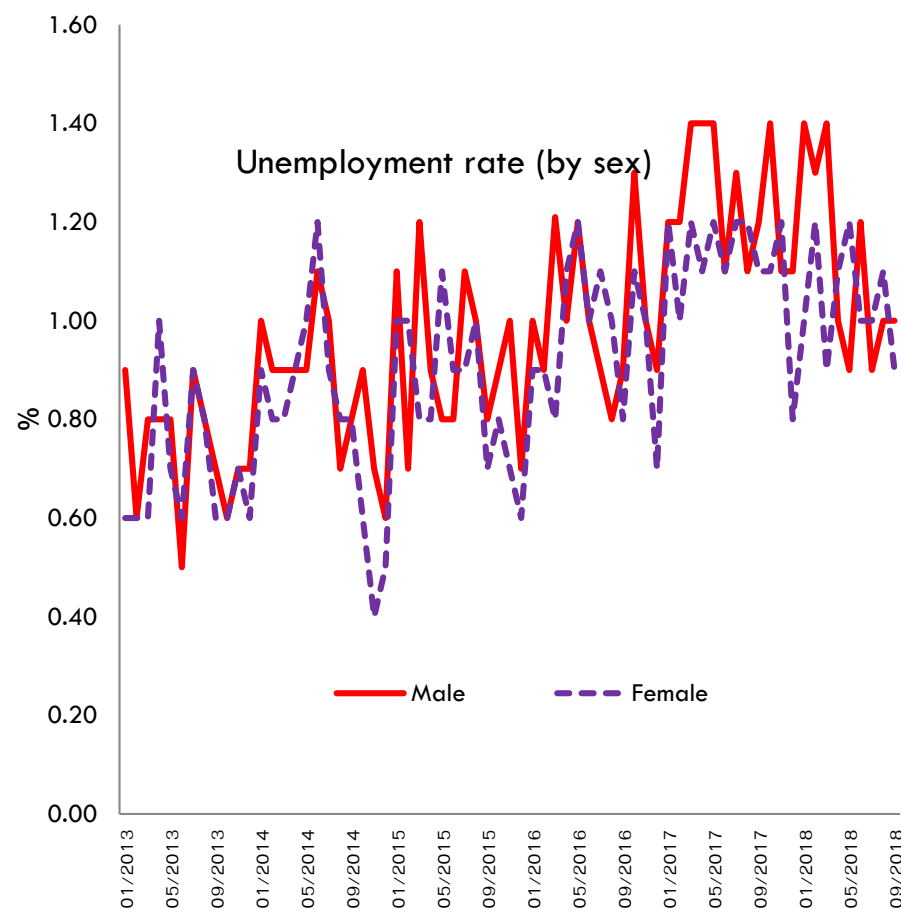
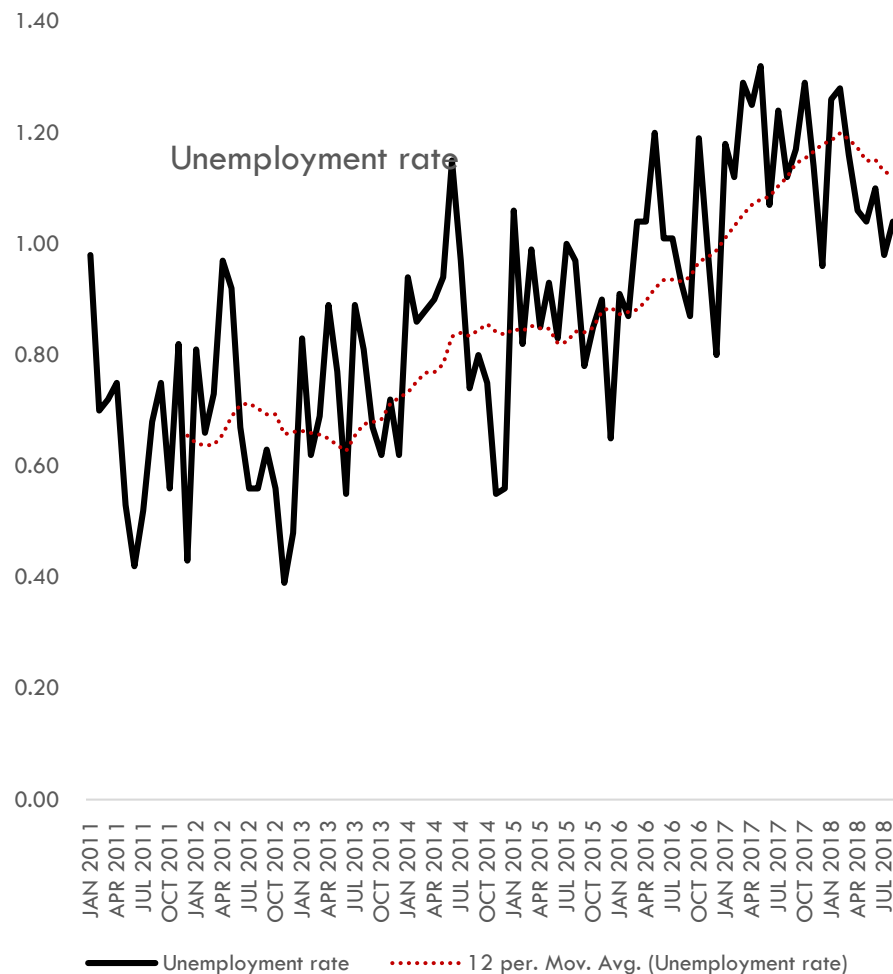
Male labor force = 65% of total labor force



UNEMPLOYMENT RATE (1/2)

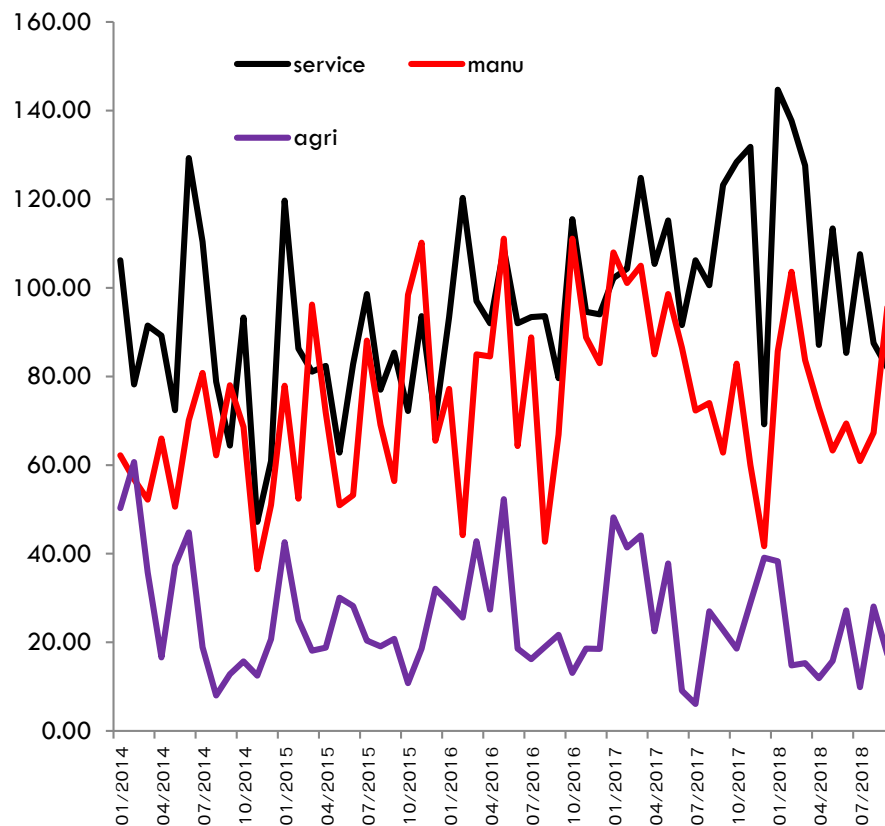
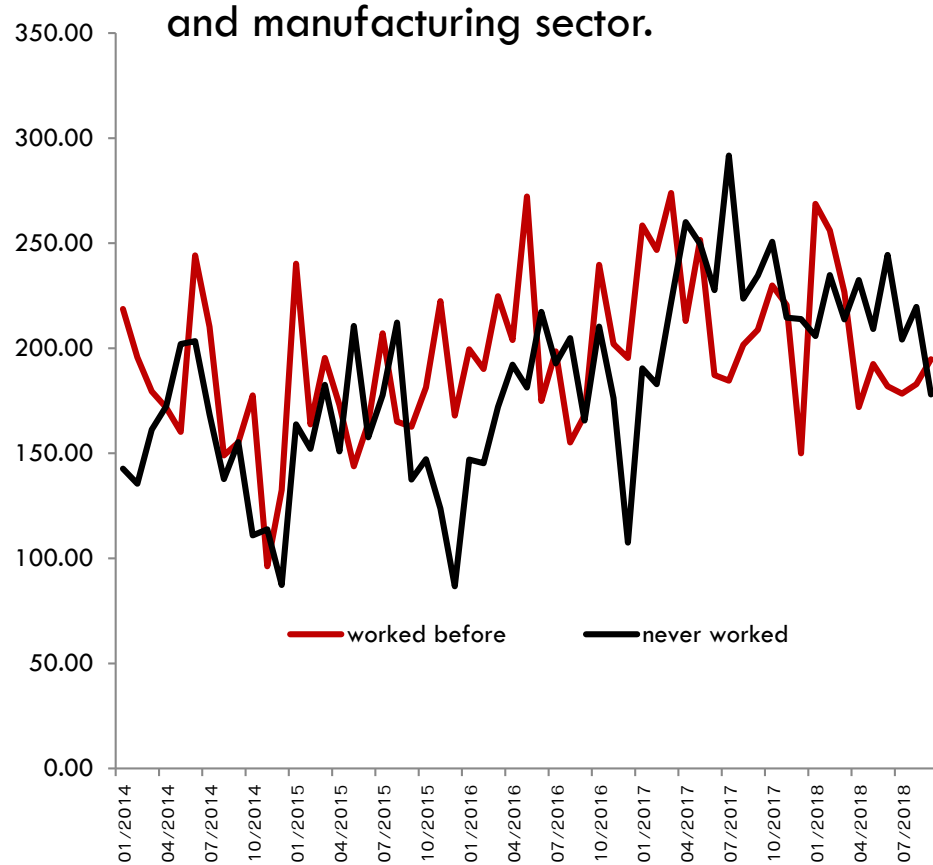
unemployment rate = unemployment / Labor force

Unemployment rates are roughly comparable across sex.



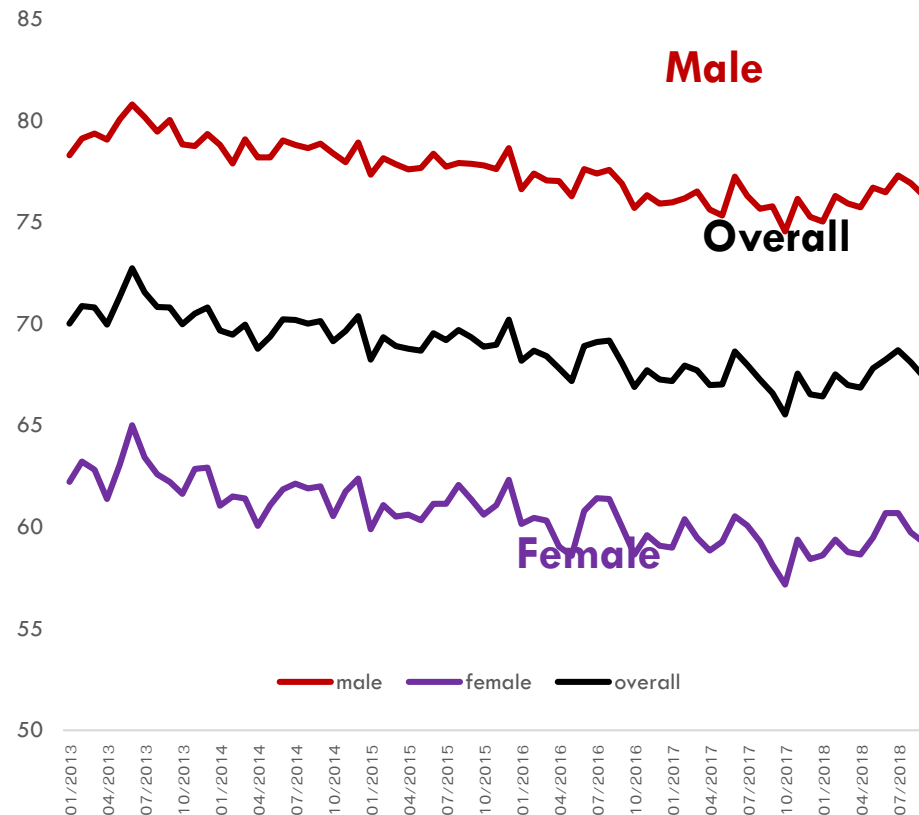
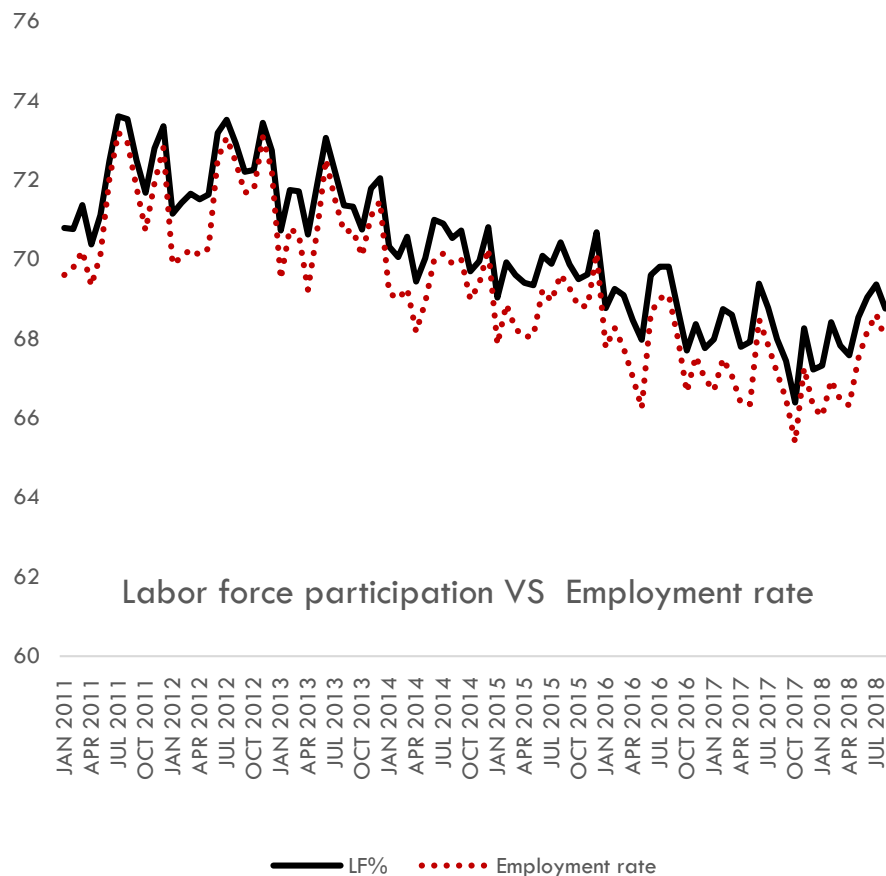
UNEMPLOYMENT RATE (2/2)

1. First-time unemployed persons are roughly comparable to repeating unemployed persons
2. Unemployed persons, classified by last job, are relatively high among service and manufacturing sector.



EMPLOYMENT RATE (1/3)

Employment rate = $\text{Employment} / \text{Pop} > 15$
 = $(\text{Employment} / \text{Labor force}) * \text{LF participation rate}$
 Female employment rate is due to lower female LF participation rate.



EMPLOYMENT RATE (2/3): WHEY DO THEY GO?

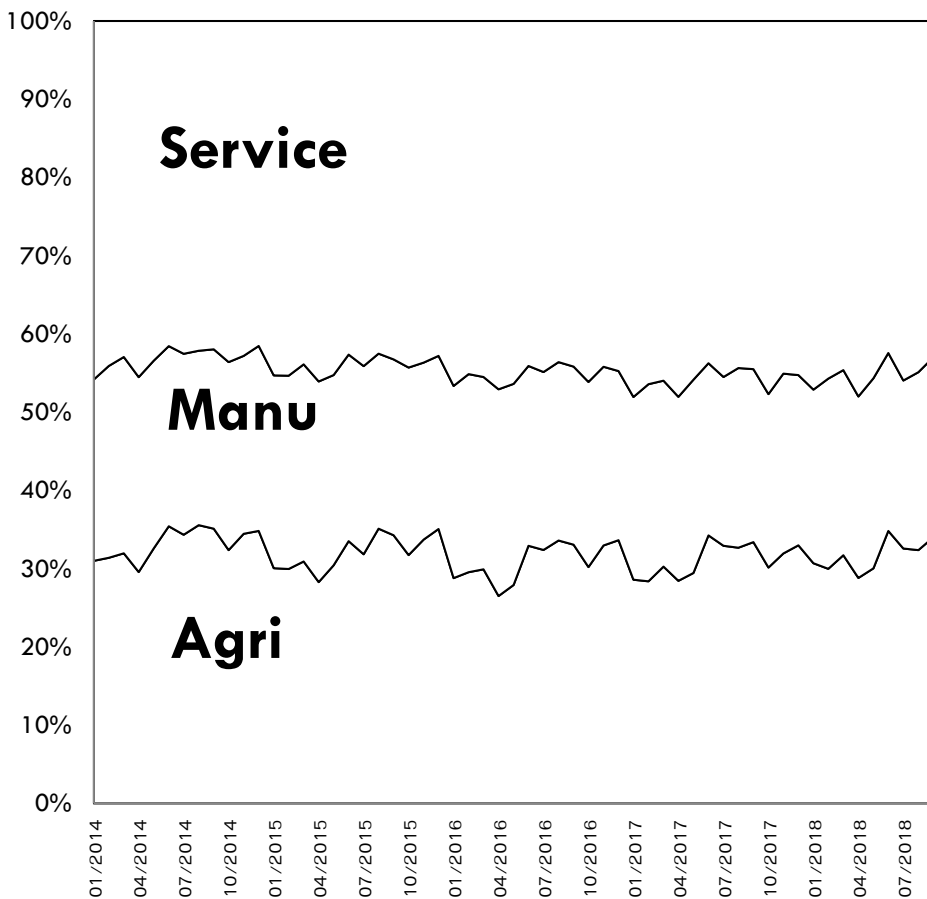
- Having classified by sex, male employment accounts for 55% of the total labor employment in Thailand
- **Informal sector** accounts for over 55% of the total labor employment in Thailand, both male and female.

	Male	Female	
Employment share	54.20	45.80	
	Overall	Male	Female
Informal	55.86	56.31	55.33
Formal	44.14	43.69	44.67

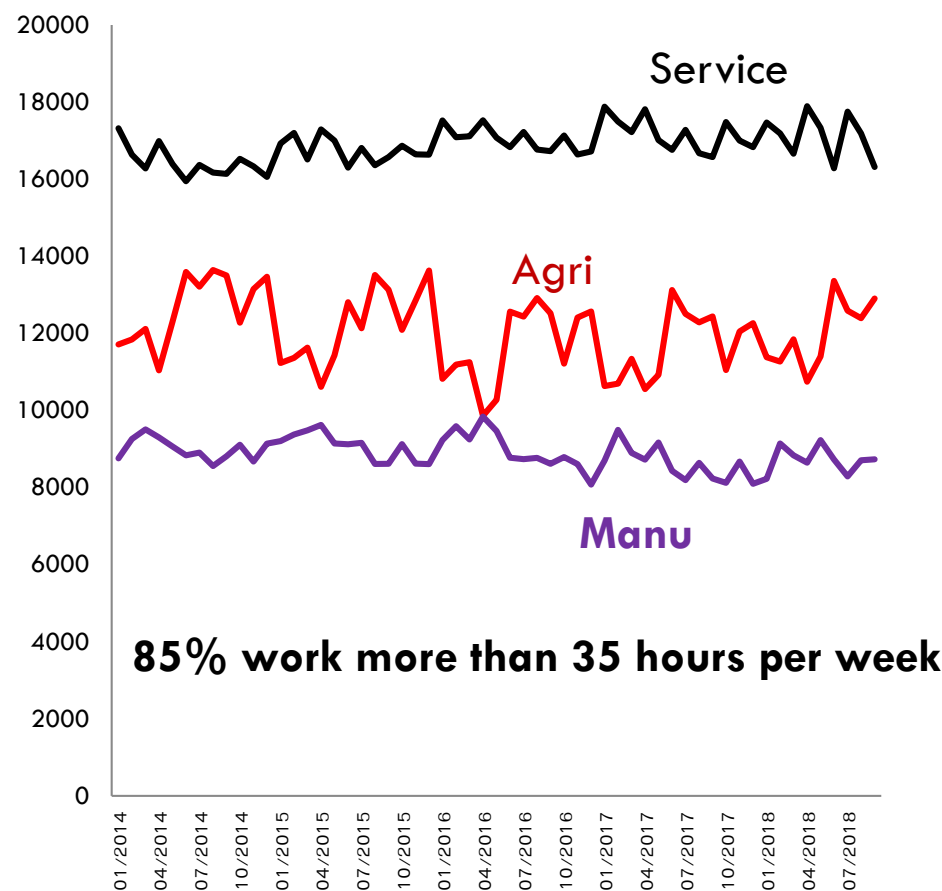
Source: NSO, informal sector survey, 2017

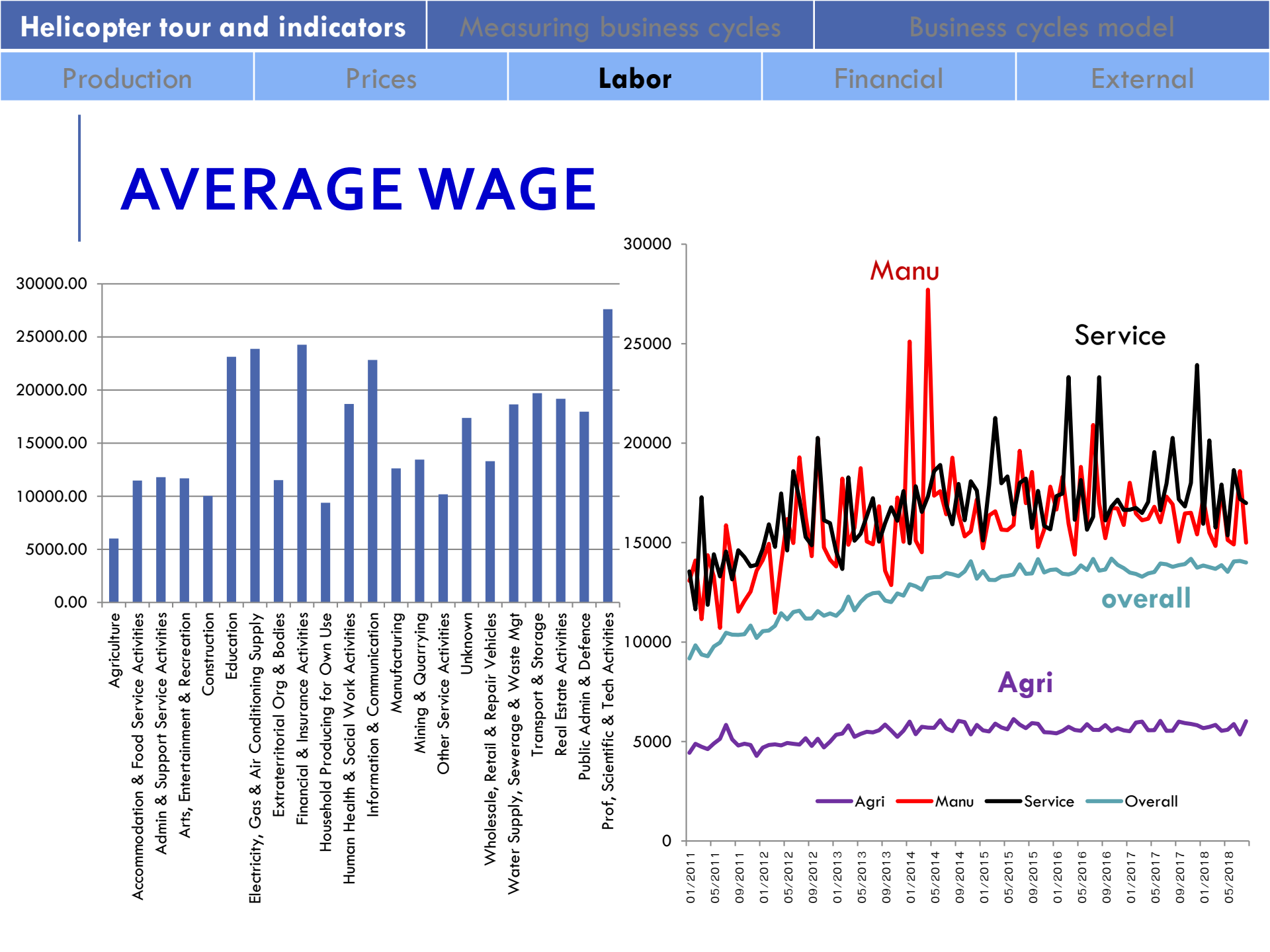
EMPLOYMENT RATE (3/3): WHEY DO THEY GO?

Sectoral employment by ISIC code (Share)



Sectoral employment (level)





MONETARY AND FINANCIAL VARIABLES

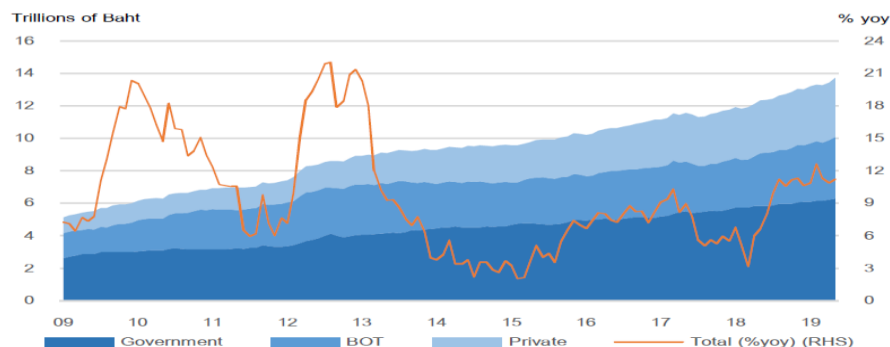
- Key important variables in financial system

Financial system	Quantity	Price
Bond market (short-term / long-term)	• Outstanding value of instruments • New issued of instruments • Market Capitalization	Short-term yield Long-term yield
Stock market		SET index
Credit market by Fis	• Saving / Time deposit • Credit intermediated by Fis	Saving rate / Time-deposit rate MLR, MRR

MONETARY AND FINANCIAL VARIABLES

Key indicators in bond market

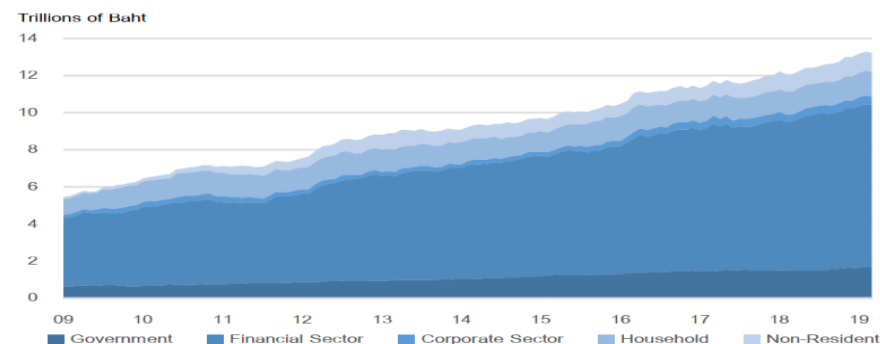
Outstanding of Debt Securities in Thailand by Issuer [M]



Source: Thai Bond Market Association, Securities and Exchange Commission, and Bank of Thailand

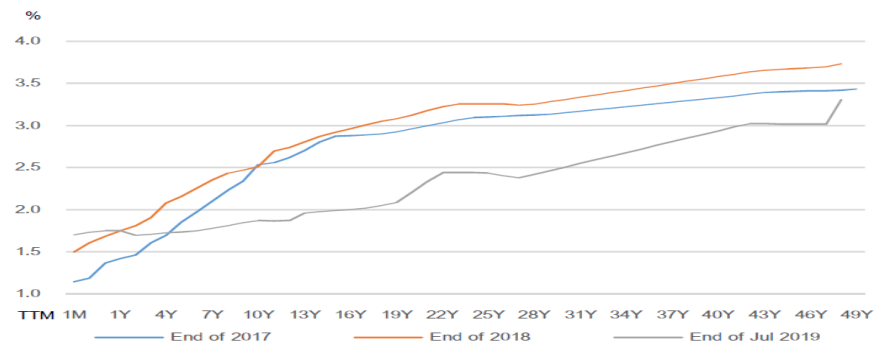
Remark: Private Issuer refers to corporates and non-residents

Outstanding of Debt Securities in Thailand by Holder [M]



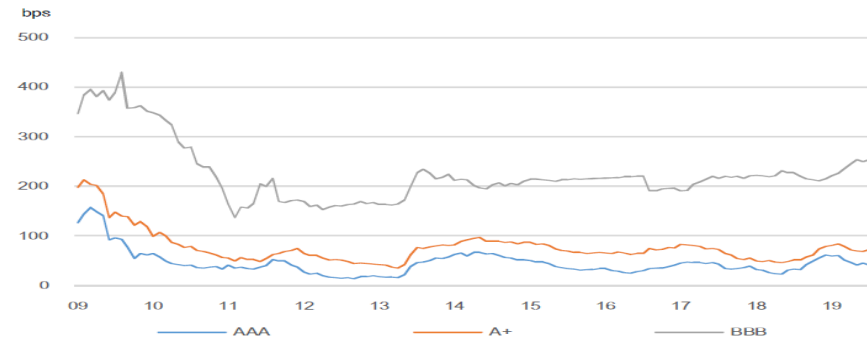
Source: Thai Bond Market Association, Securities and Exchange Commission, and Bank of Thailand

Government Bond Yield Curve [M]



Source: Thai Bond Market Association

Thai Corporate Bond Spreads [M]



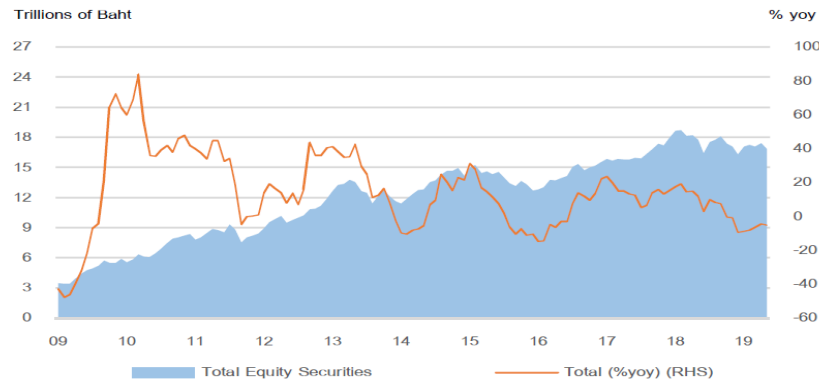
Source: Thai Bond Market Association

Remark: Spread over government bond yields for 3-year remaining maturity corporate bonds

MONETARY AND FINANCIAL VARIABLES

Key financial indicators in the stock market

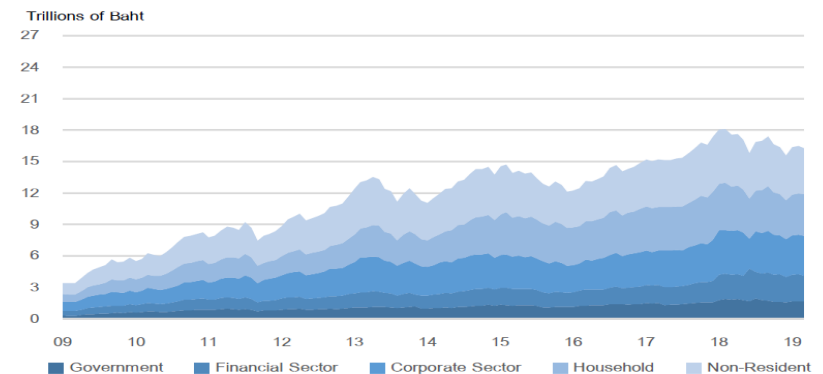
Outstanding of Equity Securities [M]



Source: Stock Exchange of Thailand, compiled by Bank of Thailand

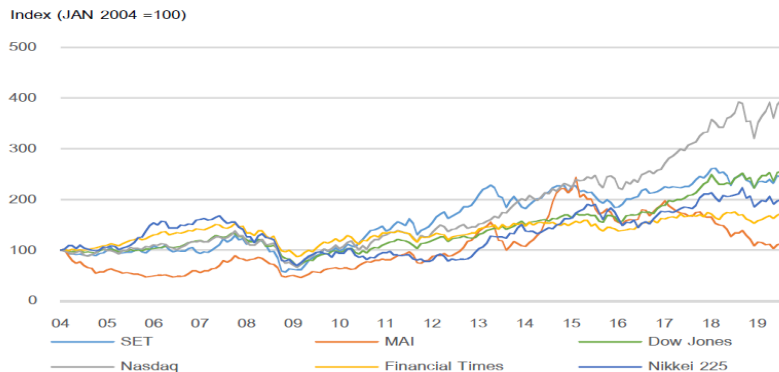
Remark: Equity Securities include common stocks and preferred stocks in SET and MAI.

Outstanding of Equity Securities by Holder [M]



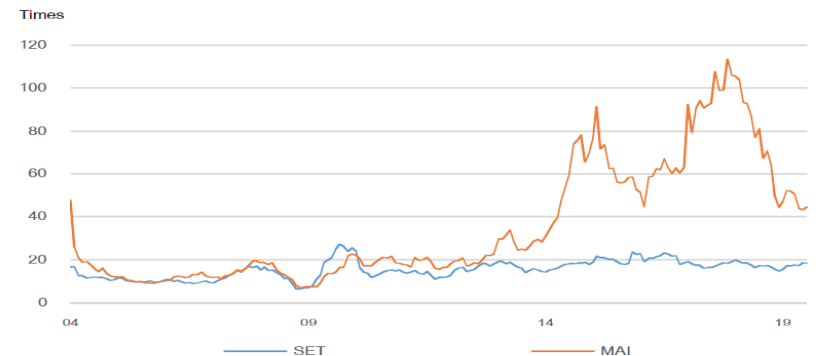
Source: Stock Exchange of Thailand, compiled by Bank of Thailand

Stock Market Indexes [M]



Source: Stock Exchange of Thailand and Reuters, calculated by Bank of Thailand

P/E Ratio [M]

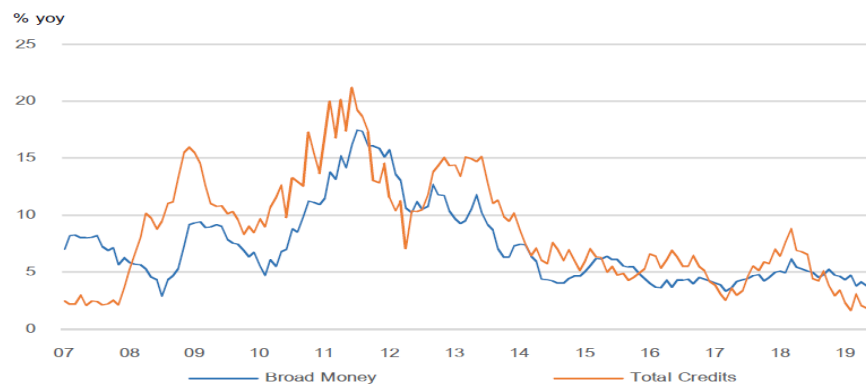


Source: Stock Exchange of Thailand

MONETARY AND FINANCIAL VARIABLES

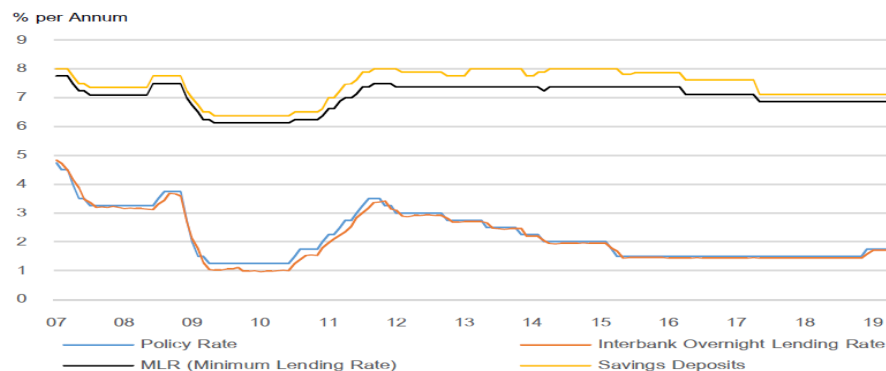
Key financial indicators in the banking sector

Broad Money & Credit Growth



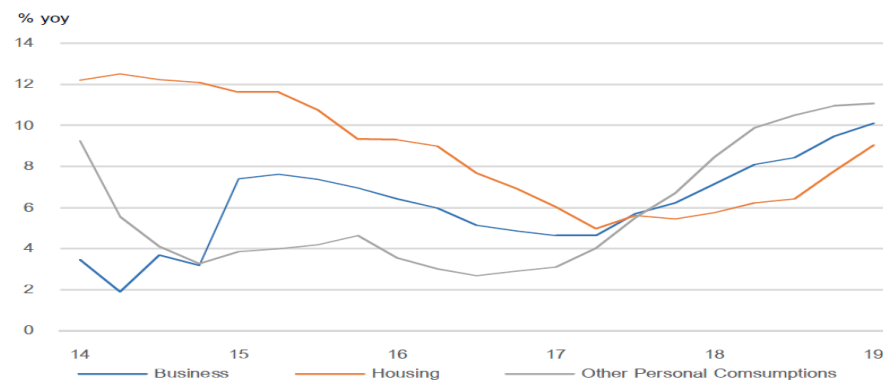
Source: Bank of Thailand (Board Money ) (Total Credits )
 Remark: Other depository corporations' credits

Interest Rate



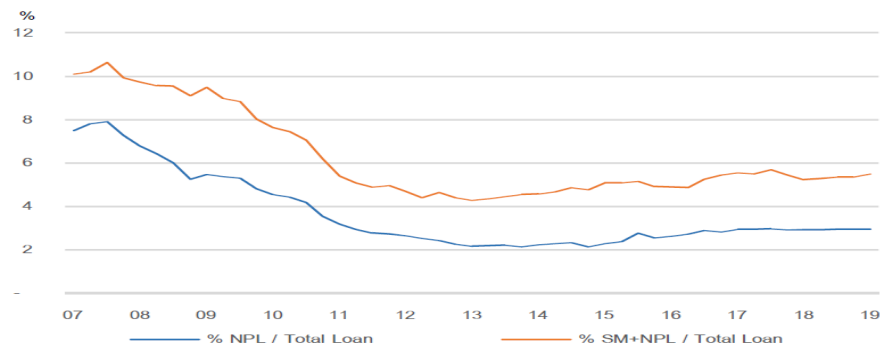
Source: Bank of Thailand 
 Remark: MLR and saving deposit interest rates are maximum rate.

Credit Growth by Sector



Source: Bank of Thailand 
 Remark: Commercial banks' credits only

Non-Performing Loan



Source: Bank of Thailand 
 Remark: SM = Special Mention Loan, NPL = Non-Performing Loan
 SM + NPL are outstandings of commercial banks only

Helicopter tour and indicators		Measuring business cycles		Business cycles model	
Production	Prices	Labor	Financial	External	

EXTERNAL VARIABLES

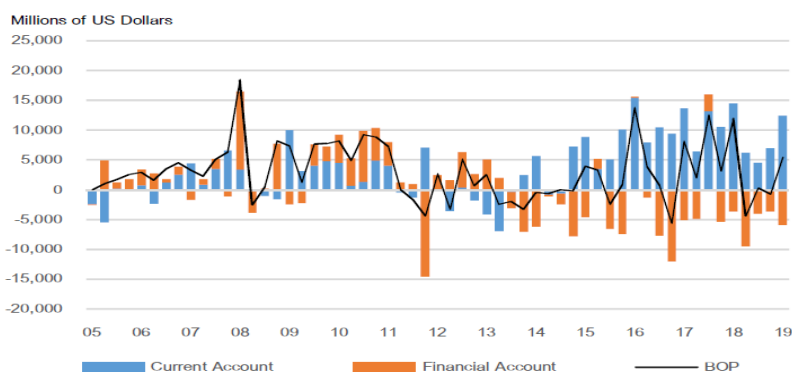
- Exchange rates
- Balance of payments, Capital flows, current accounts
- FDI
- Economic activities of trading partners

EXTERNAL VARIABLES

Key indicators for measuring external conditions

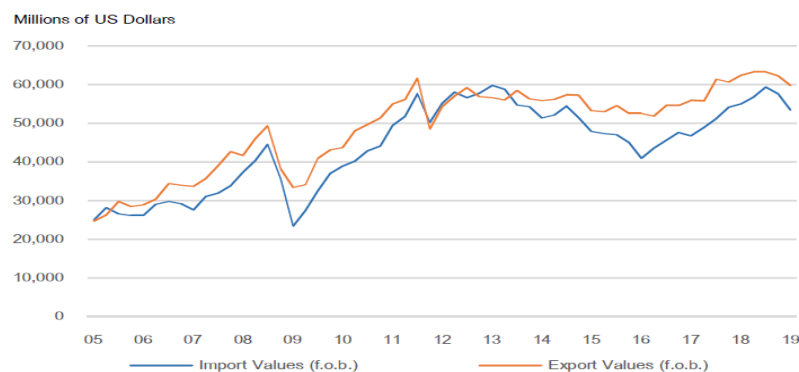
Balance of Payments

[Q]



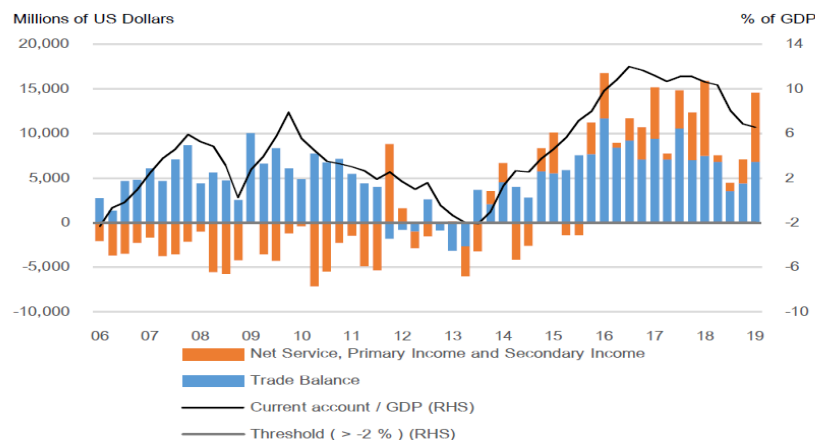
International Trade

[Q]



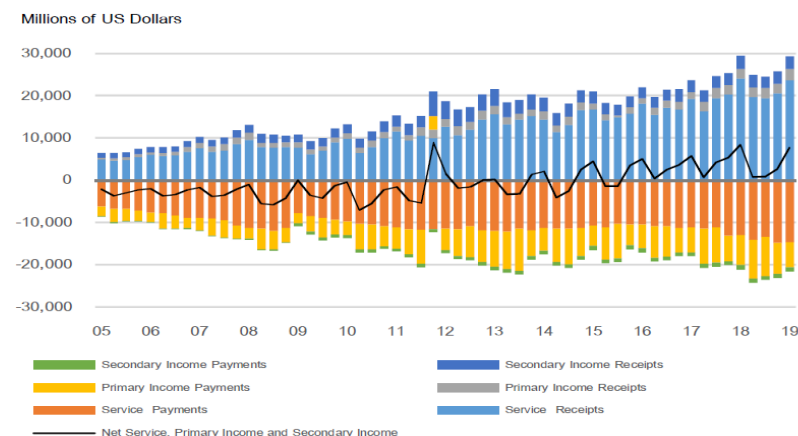
Current Account Components and Current Account to GDP

[Q]



Service, Primary Income and Secondary Income

[Q]



Source: Bank of Thailand

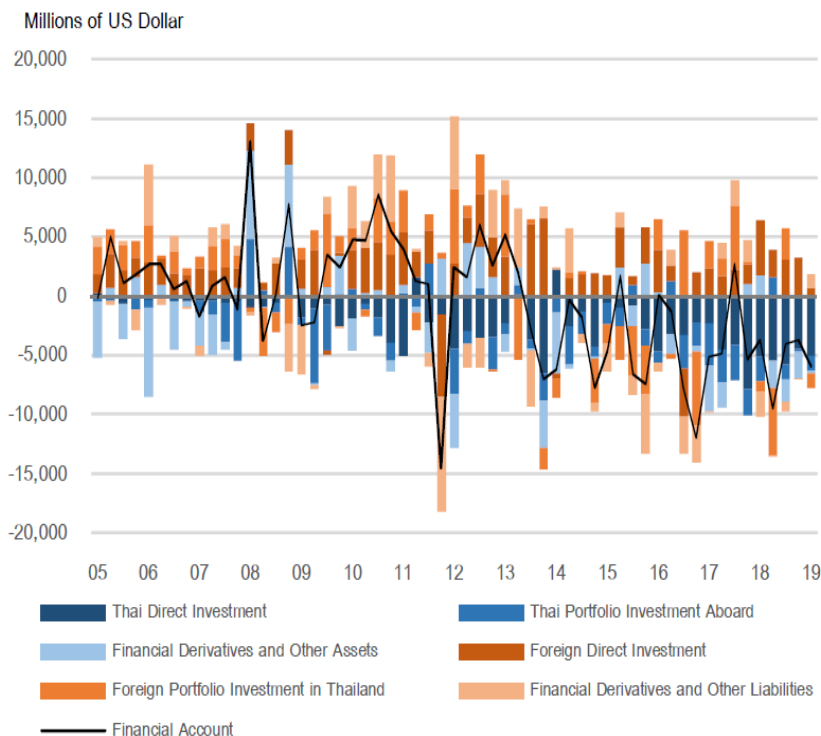
Source: Bank of Thailand

EXTERNAL VARIABLES

Key indicators for measuring external conditions

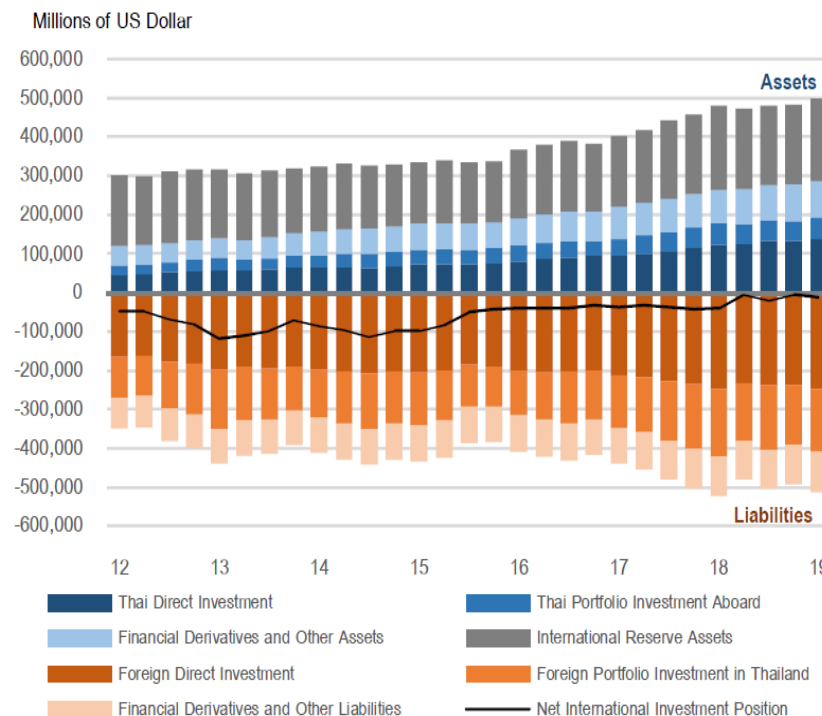
Financial Account

[Q]



International Investment Position

[Q]



Source: Bank of Thailand

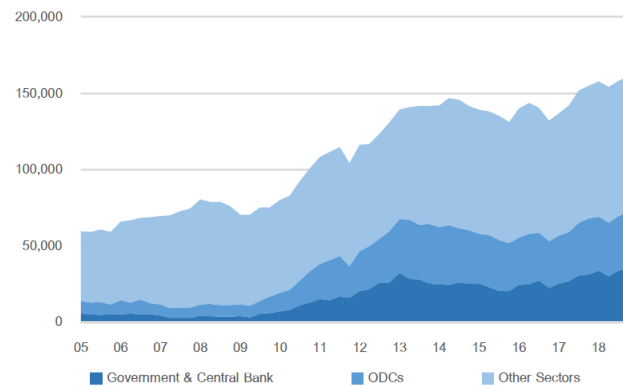
Source: Bank of Thailand

EXTERNAL VARIABLES

Key indicators for measuring external conditions

External Debt by Sector

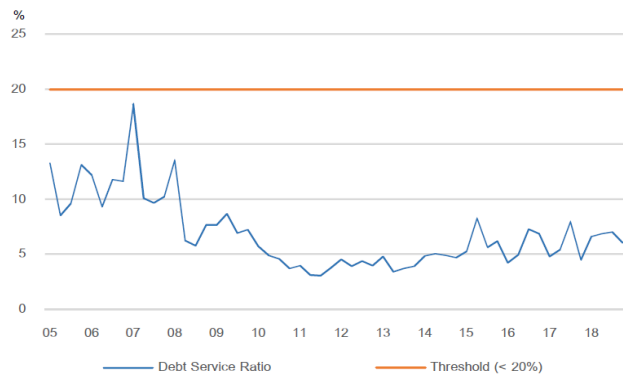
Millions of US Dollars



Source: Bank of Thailand

Remark: Other Depository Corporations (ODCs) comprise domestically registered commercial banks, branches of foreign banks, international banking facilities, finance companies and specialized banks.

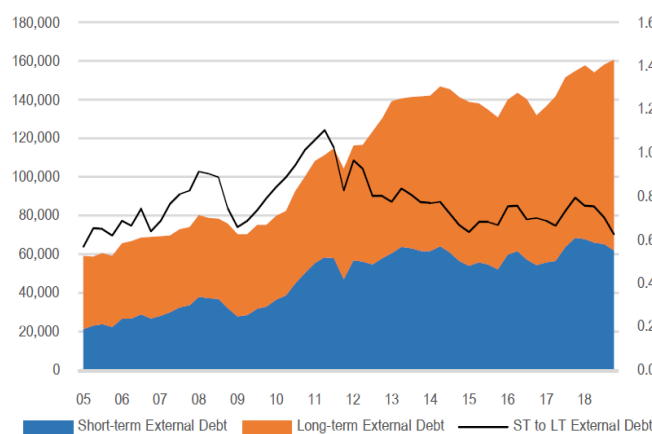
Debt Service Ratio on External Debt



Source: Bank of Thailand

[Q] Short and Long Term External Debt

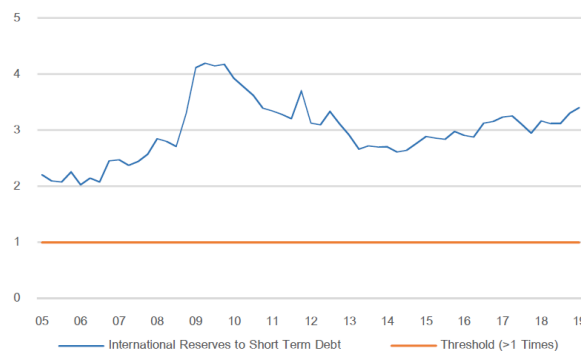
Millions of US Dollars



Source: Bank of Thailand

[Q] International Reserves to Short Term Debt

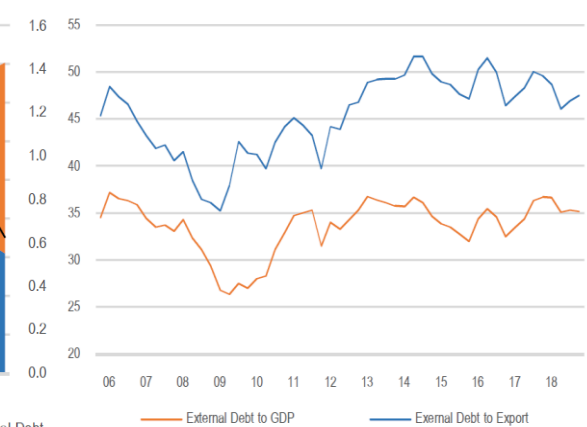
Ratio



Source: Bank of Thailand

[Q] External Debt to GDP & External Debt to Export

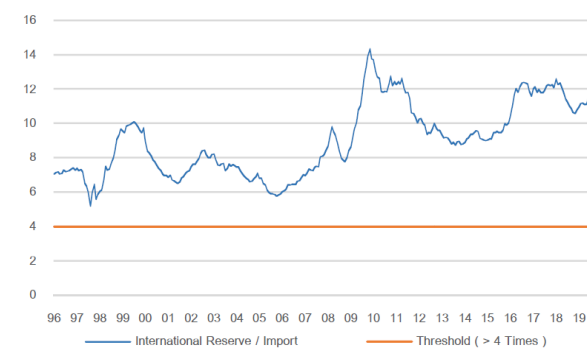
Ratio %



Source: Bank of Thailand

[Q] International Reserves to Import

Months



Source: Bank of Thailand

AGENDA



- ~~A helicopter tour on the macroeconomy and key economic indicators~~
- Measuring business cycles
- Business cycle models: aims and ingredients

TIME SERIES DATA: SOME TECHNICAL JARGONS

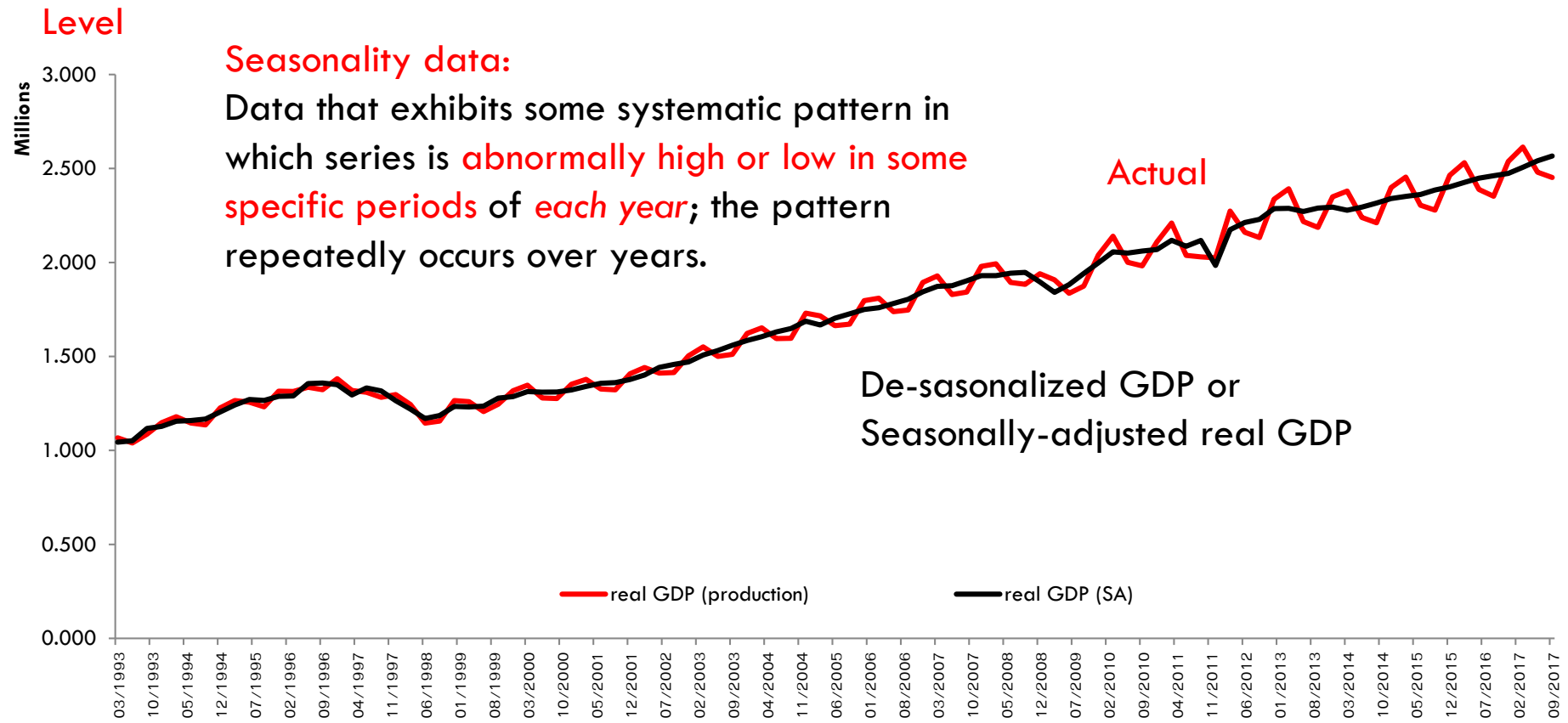
- Most aggregate variables are **time series**; data value can be observed at each point of time.
- Having referred to time-series data, one common approach is to characterize behavior of the data is to think about the **decomposition**.

$$X = T + C + S$$

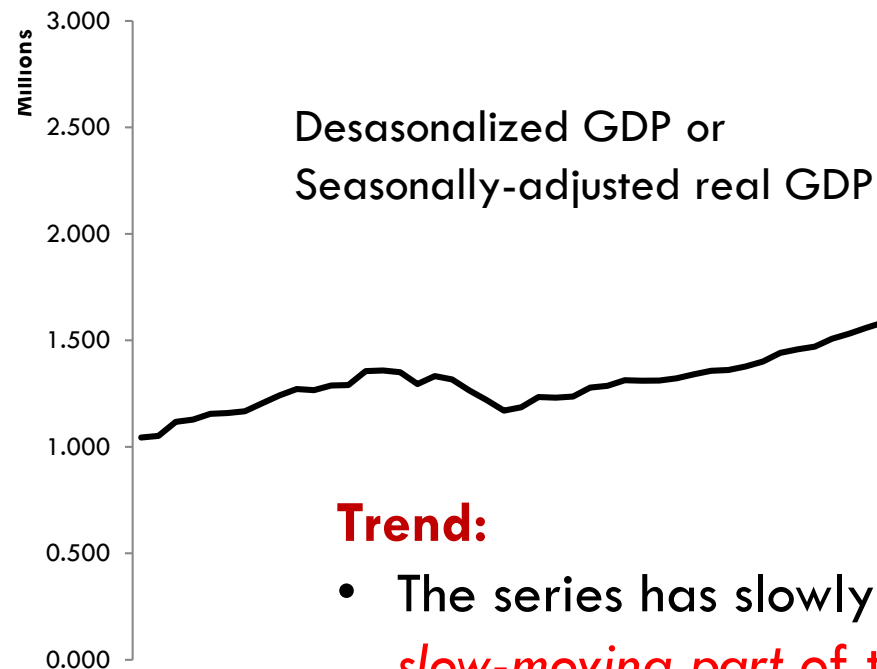
X = actual T = trend; C=Cycle; S = Seasonal

For example: GDP = Trend GDP + Cycle GDP + Seasonal part

ACTUAL REAL GDP HAS CONTAINED SOME SEASONAL EFFECTS.



SEASONALLY-ADJUSTED REAL GDP HAS SLOWLY MOVED AND GROWN OVER TIME.



Trend:

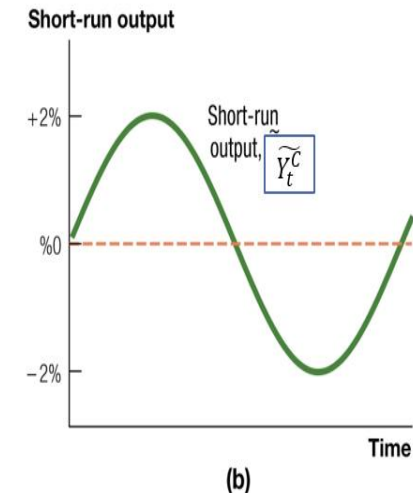
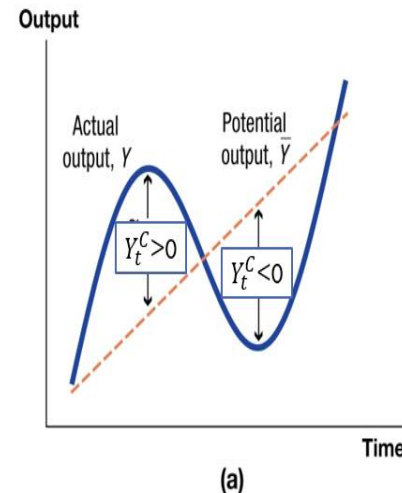
- The series has slowly moved and grown over time. **The *slow-moving part of the series* is called “trend”.**
- In economics, this trend is given by **long-term factors**, i.e. **potential growth of the economy.**

Detrending and Cyclical Fluctuations: measurement?

- Output is equal to the **long-run trend** plus **de-trended component**. The latter is called the cyclical part, i.e. short-run fluctuations:
 - The long-run trend is referred to **potential output**.
- Cyclical measurement is usually made in percentage (**why? Normalization!**)
- The short-run fluctuations are the percentage deviations from potential GDP.

$$Y_t = \bar{Y}_t + Y_t^C$$

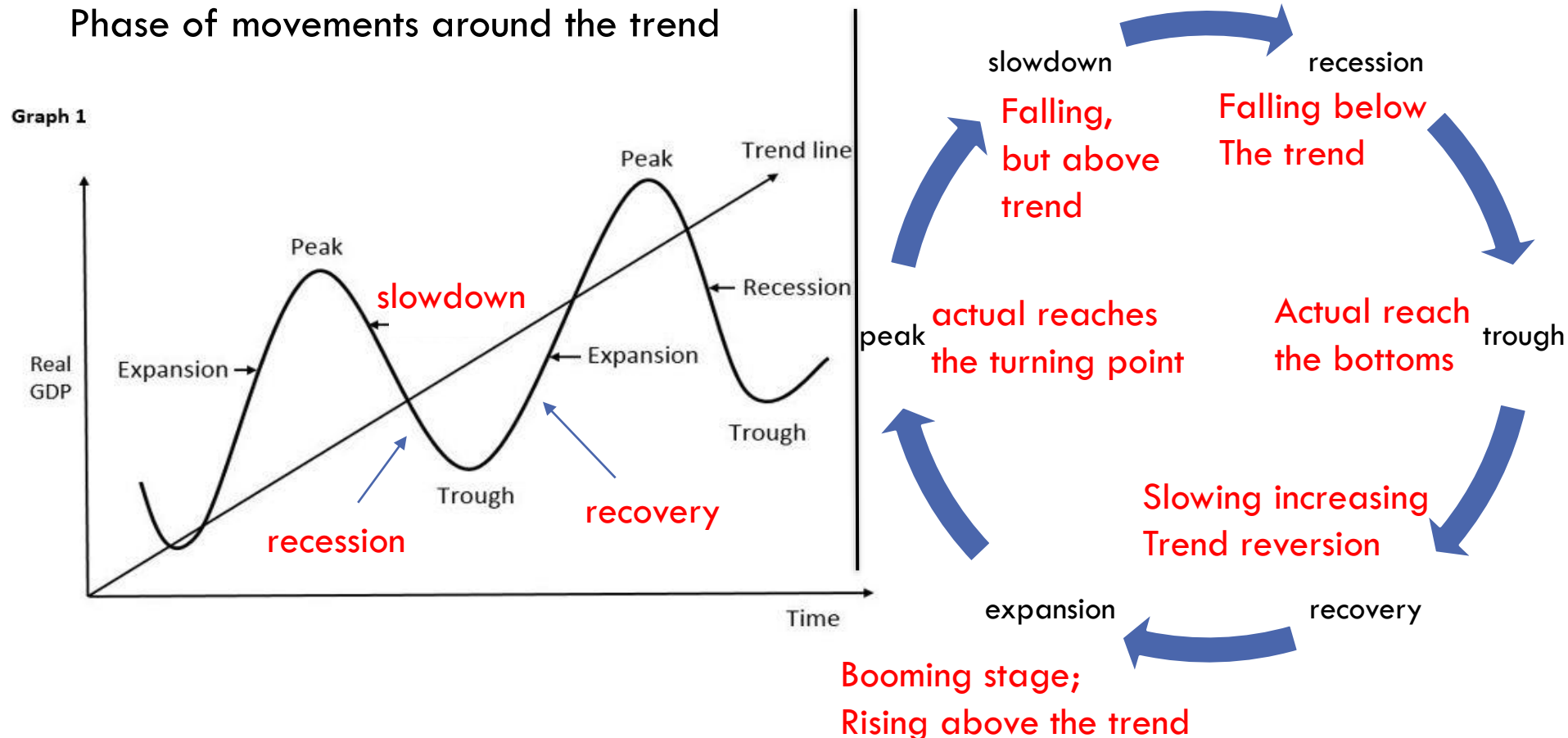
$$\widetilde{Y}_t^C = \frac{Y_t - \bar{Y}_t}{\bar{Y}_t} = \ln Y_t - \ln \bar{Y}_t$$



PHASE OF MOVEMENT AROUND TREND: CYCLICAL FLUCTUATIONS

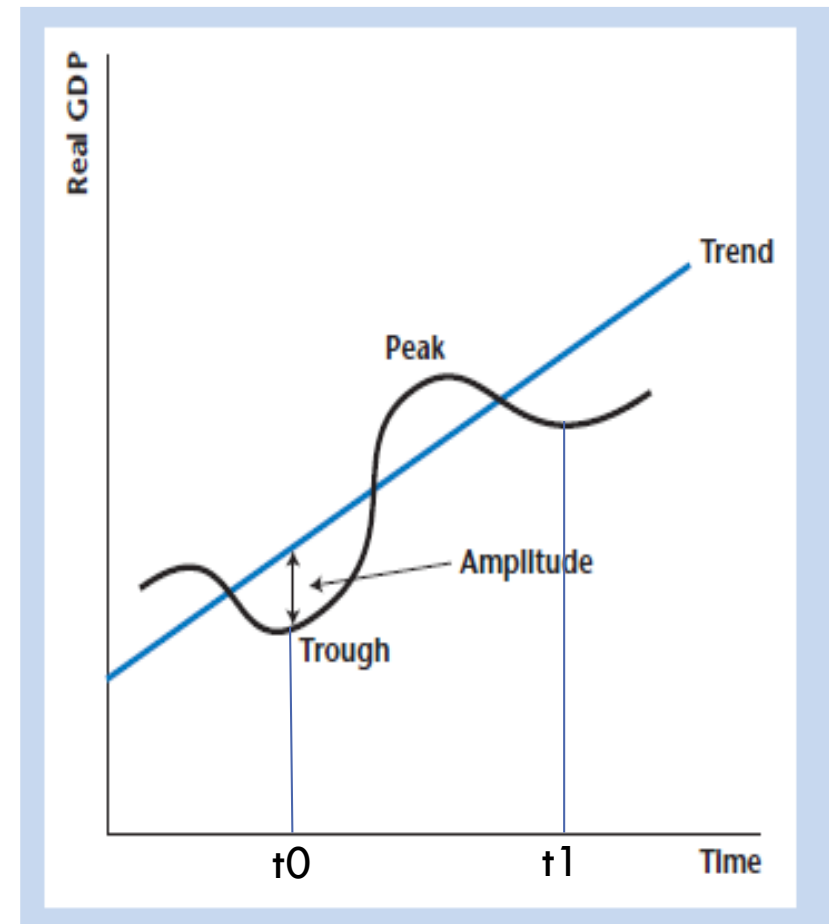
Recurrent fluctuations of economics variables that have repeatedly occurred.

Phase of movements around the trend



HOW DO WE DOCUMENT THE PATTERN OF BUSINESS CYCLES?

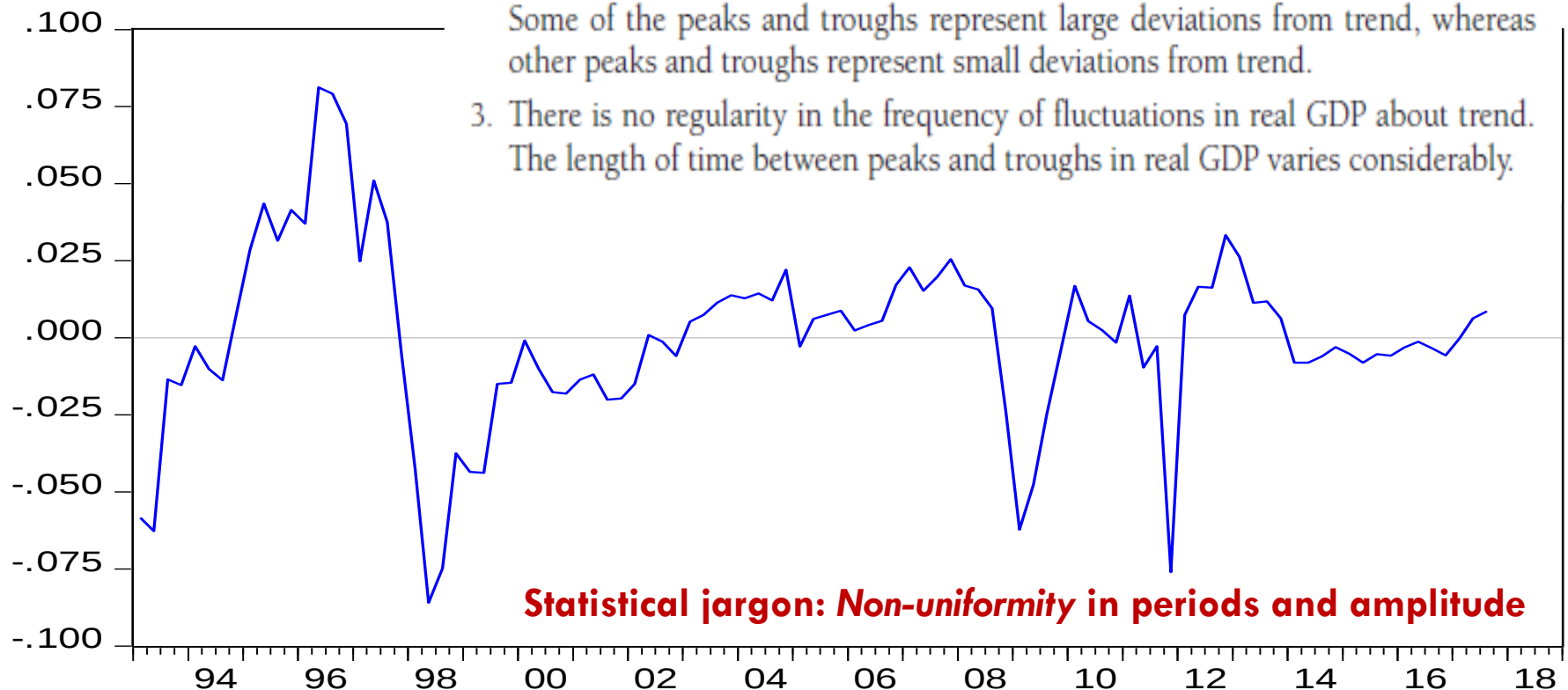
1. **Amplitude of the cycle:** Trough-to-Peak or trough-to-trend
 2. **Periods of cycle:** periods (in quarter) for having one complete cycle: **trough to trough ($t_0 \rightarrow t_1$)**
- Ideally, you would hope that information for the two things can be determined with certainty!
 - **Unfortunately, no. They are random!**



HOW DO WE DOCUMENT THE PATTERN OF BUSINESS CYCLES?

1. The time series of deviations from trend in real GDP is quite choppy.
2. There is no regularity in the amplitude of fluctuations in real GDP about trend. Some of the peaks and troughs represent large deviations from trend, whereas other peaks and troughs represent small deviations from trend.
3. There is no regularity in the frequency of fluctuations in real GDP about trend. The length of time between peaks and troughs in real GDP varies considerably.

Statistical jargon: Non-uniformity in periods and amplitude



HOW DO WE DOCUMENT THE PATTERN OF BUSINESS CYCLES? → USING STATISTICAL TECHNIQUE

- Because cycles are random, economists then apply some **statistical methods** to describe/characterize the pattern of business cycles.
- Treating cyclical variable as a random variable, and describe its statistical properties using some statistic
- What statistic do business cycle economists usually look into?
 - Average length / Average amplitude of cycle
 - Volatility
 - Comovement
 - Leading and Lagging

STATISTICAL MEASUREMENT OF BUSINESS CYCLES

- **How volatile is the cyclical variable?**
 - Volatility can be measured by using the **standard deviation** concept
- **Comovement of cyclical variables**
 - Economists usually focus on the relationship among various cyclical variables
 - Types of comovement: **positive, negative and zero**

BUSINESS CYCLES COMOVEMENT

Figure 3.3 Time Series Plots of x and y

(a) Two time series that are positively correlated. When x is high (low), y tends to be high (low) as well. (b) Two time series that are negatively correlated. In this case, when x is high (low), y tends to be low (high).

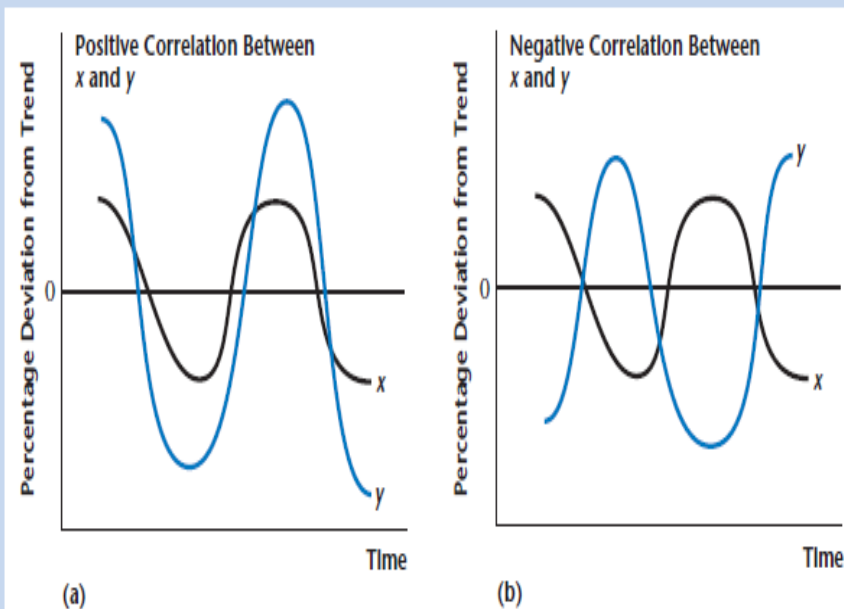
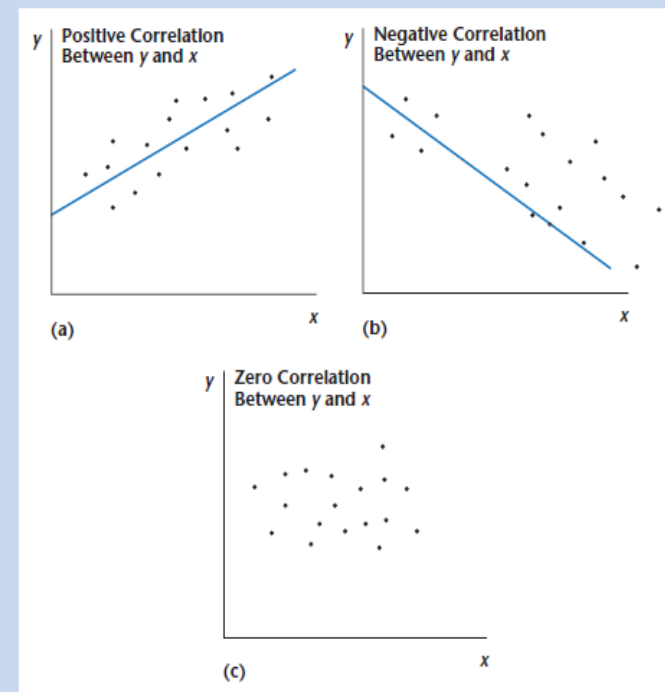


Figure 3.4 Correlations Between Variables y and x

(a) A scatter plot of two variables, x and y , that are positively correlated. (b) x and y are negatively correlated. (c) x and y are uncorrelated.



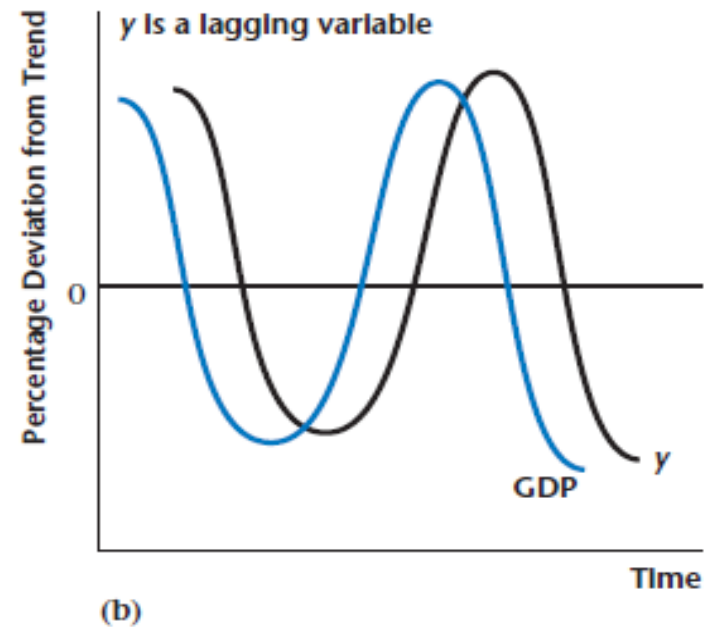
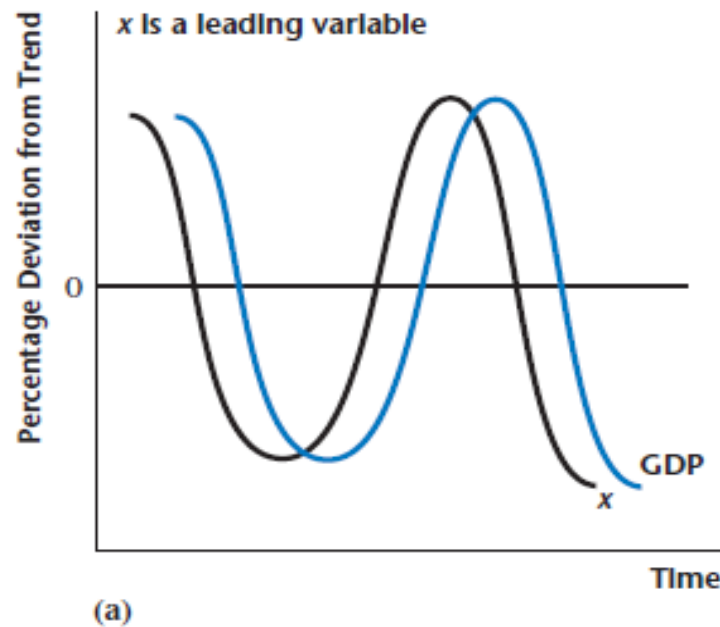
BUSINESS CYCLES COMOVEMENT

- Typically, we measure the degree of comovement using the “**correlation**”, rather than the covariance. (Why?)
- Conventional treatment: A variable “X” is said to be
 - A **procyclical variable** if $\text{corr}(\text{GDP}, x) > 0$.
 - A **counter-cyclical** variable if $\text{corr}(\text{GDP}, x) < 0$.
 - **Acyclical variable** if $\text{corr}(\text{GDP}, x) = 0$

BUSINESS CYCLE: LEADING AND LAGGING VARIABLES

Figure 3.7 Leading and Lagging Variables

In (a), x is a leading variable, as its peaks and troughs tend to precede those of real GDP. In (b), y is a lagging variable, as the peaks and troughs in real GDP tend to lead those in y .



BUSINESS CYCLE: LEADING AND LAGGING VARIABLES

- How to detect “leading” and “lagging” relationship
- Simple approach: **cross correlation**
- A more sophisticated approach is to adopt the **predictive regression** method.
- Conventional understanding: **financial variables**, housing investment, retail sale etc...

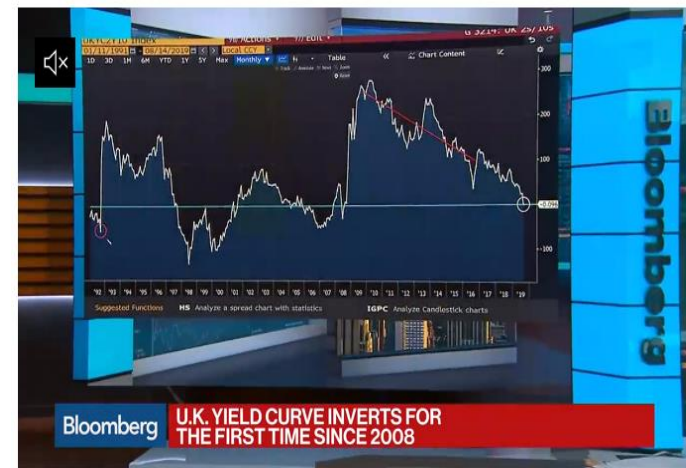
Markets

Bond Rally Charges On With 30-Year Treasury Yields Below 2%

By Katherine Greifeld, Ruth Carson, and John Ainger

August 14, 2019, 4:56 PM GMT+7 Updated on August 15, 2019, 1:10 PM GMT+7

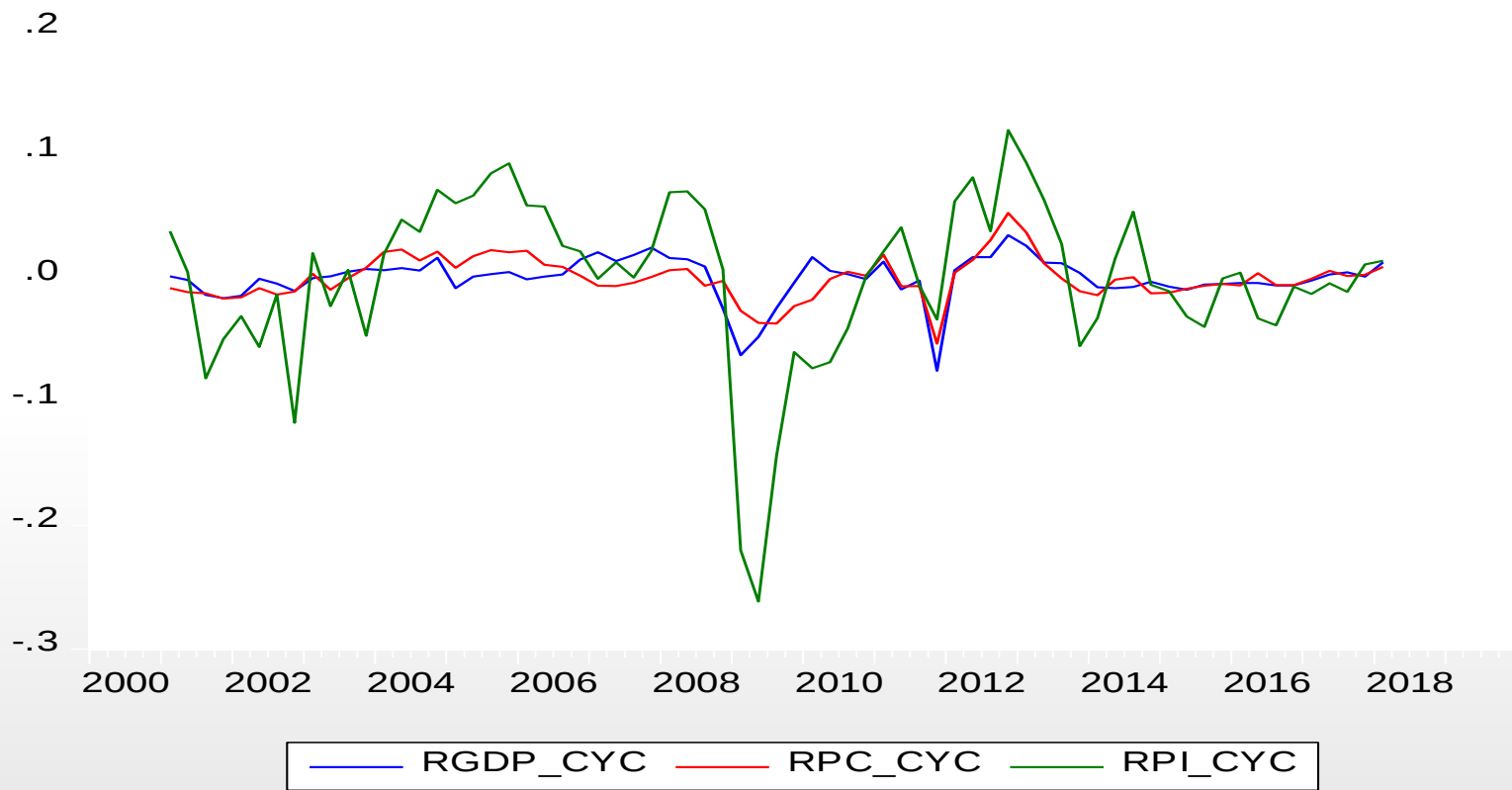
- U.S. 10-year yields drop below that of 2-year to sound alarm
- Yield curve inversion is viewed as a harbinger of recession



Brexit's Impact on Gilts, the Pound and the U.K. Economy



CYCLICAL VARIATIONS OF GDP AND ITS SELECTIVE COMPONENTS

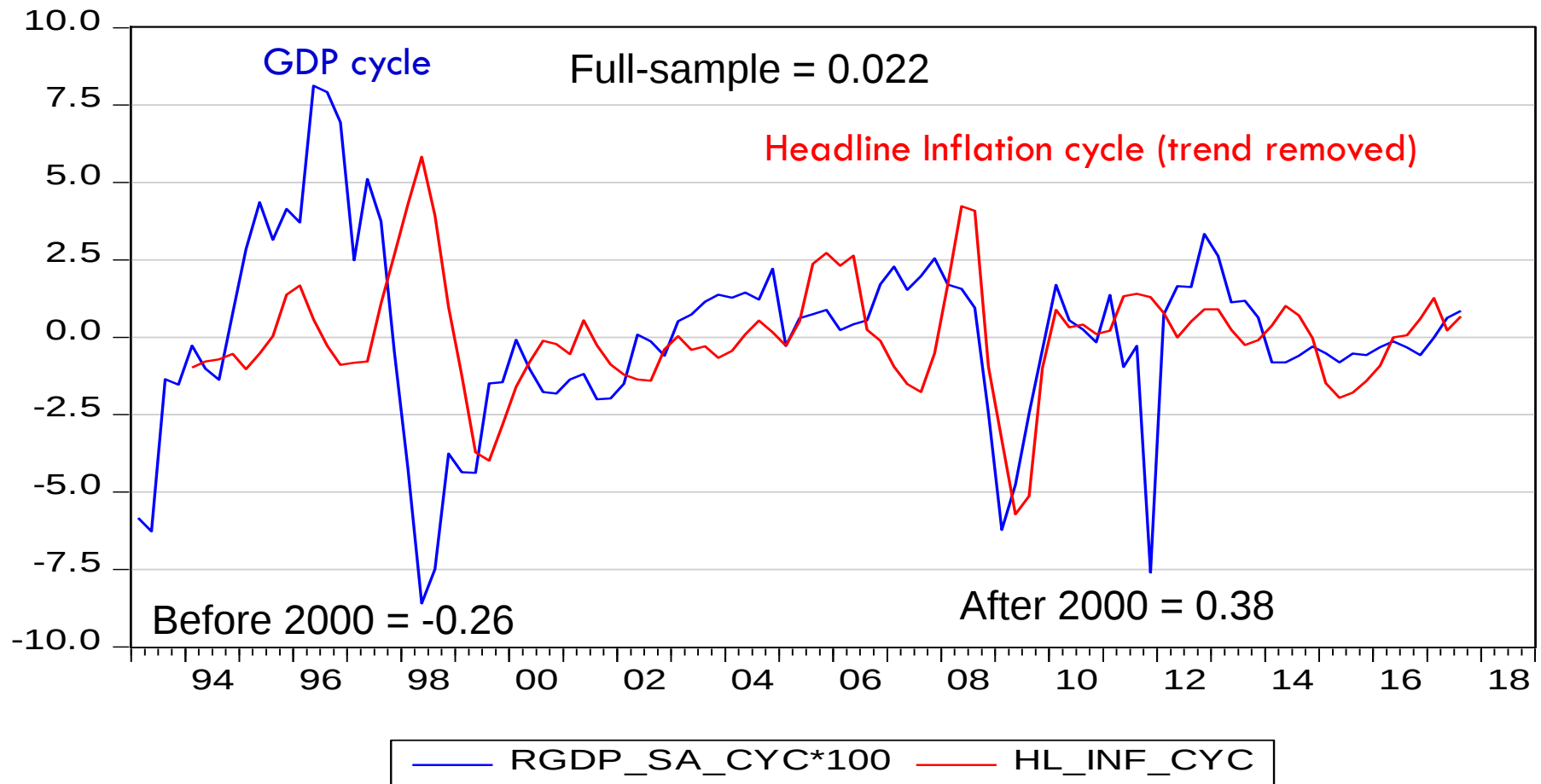


MEASURING BUSINESS CYCLES OF GDP AND ITS COMPONENT

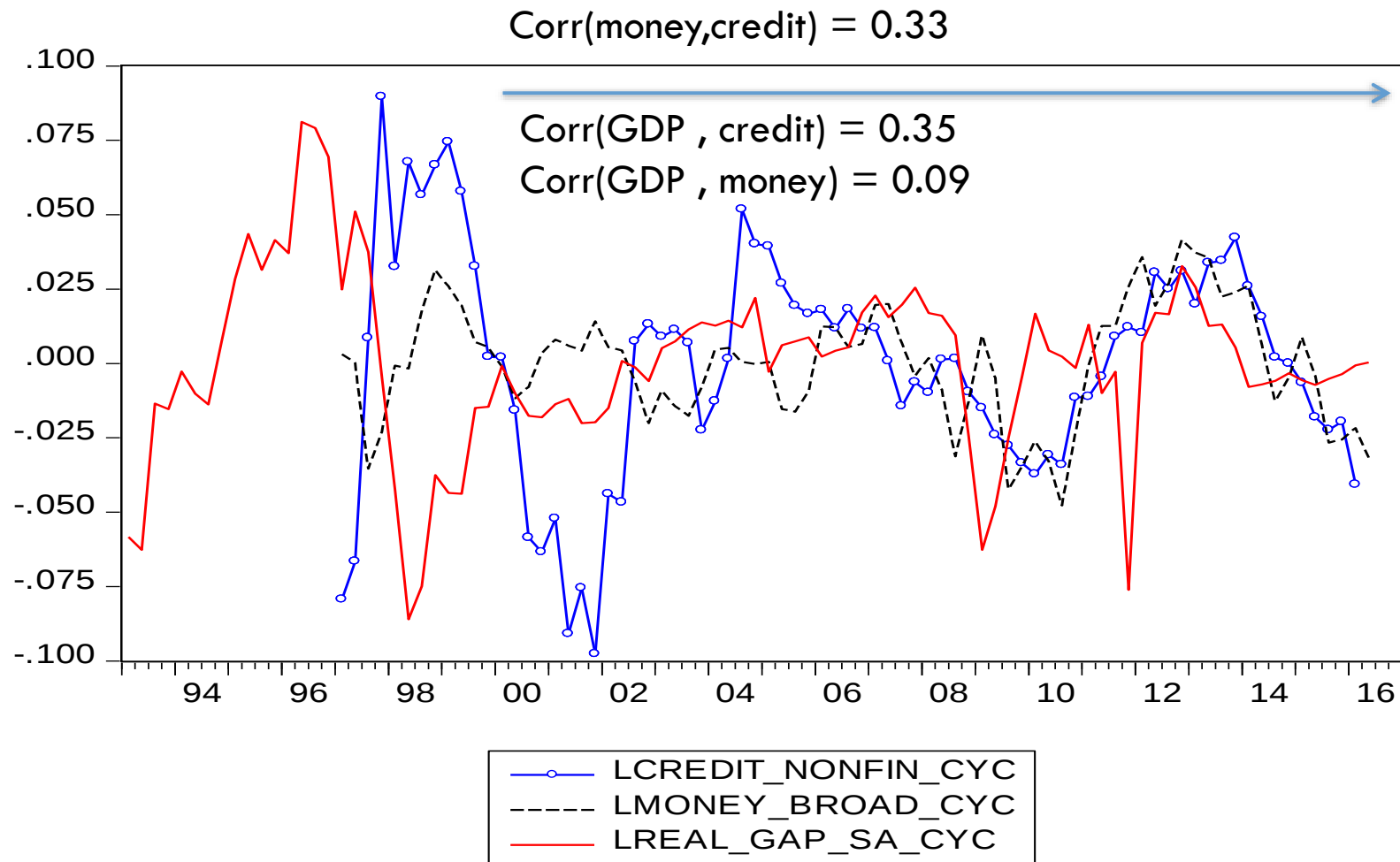
Variable	GDP	RPC	RPI
S.D.	0.017 (1.7%)	0.016 (1.6%)	0.065 (6.5%)

- Comovement:
 - $\text{Corr}(\text{GDP}, \text{RPC}) = 0.72$
 - $\text{Corr}(\text{GDP}, \text{RPI}) = 0.64$
 - $\text{Corr}(\text{RPC}, \text{RPI}) = 0.74$
- They are all procyclical variables

BUSINESS CYCLES: GDP AND INFLATION

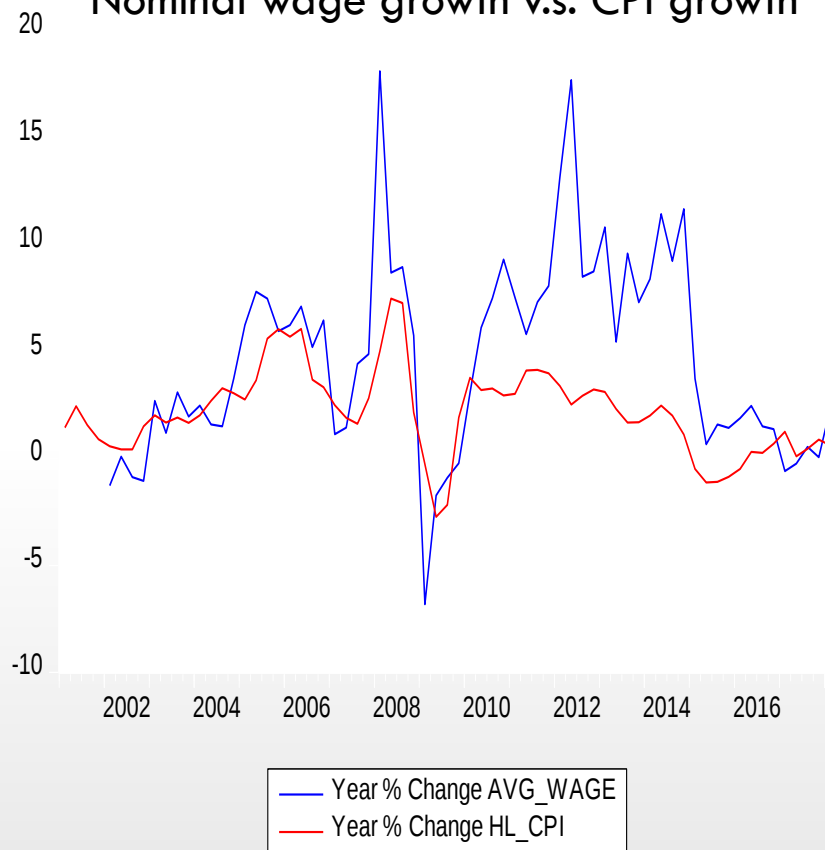


BUSINESS CYCLES: GDP, MONEY AND CREDIT



BUSINESS CYCLES: GDP, WAGE, PRICE, UNEMPLOYMENT

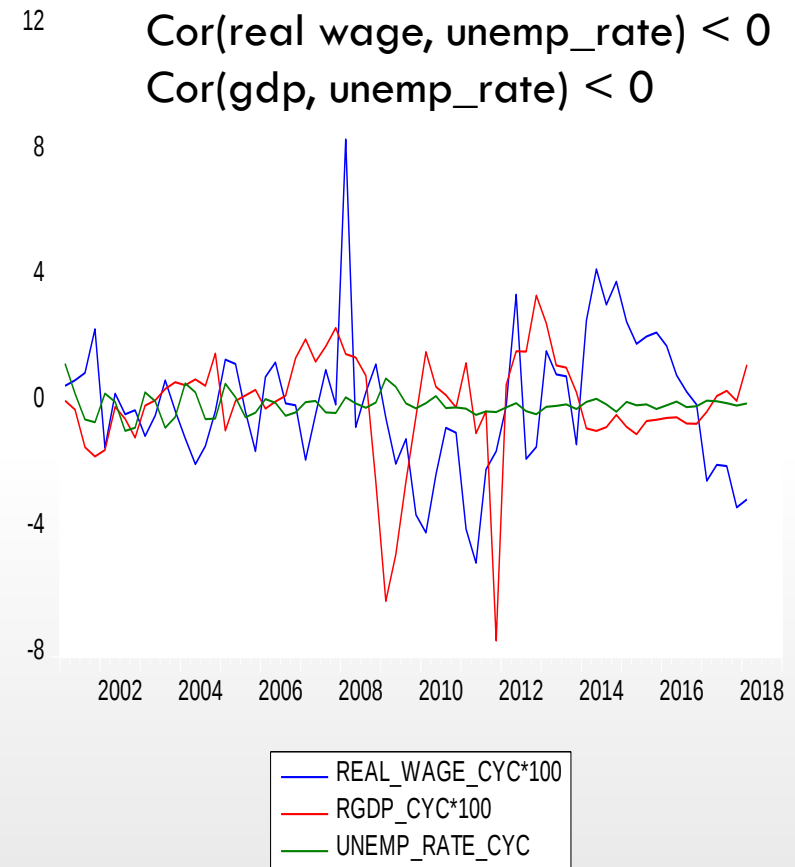
Nominal wage growth v.s. CPI growth

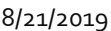


$\text{Cor}(\text{real wage, gdp}) > 0$

$\text{Cor}(\text{real wage, unemp_rate}) < 0$

$\text{Cor}(\text{gdp, unemp_rate}) < 0$





- 71

BUSINESS CYCLES MODELS: AIMS

- Making sense the pattern of cyclical variations observed in the data
 - **Volatility:** Understand when economy is prone to be subjected to high volatility?
 - **Co-movement:** Explain the interlinkages as observed in the cyclical data.
 - **Lead/Lag relationship:** why some variables are fast to move, and many are slow to adjust.

BUSINESS CYCLES MODELS: INGREDIENT

- Most business cycles model include **two important elements**
 - **The process of equilibrium determination**
 - The process that explains determination of key economic variables through using structural relationships
 - Example: Keynesian Cross, IS-LM, AD-AS model
 - **Exogenous factors (determinant)**

BUSINESS CYCLES MODELS: WHAT WE LEARN

- Aim is to understand the **transmission mechanism of shocks**
- Insights uncovered:
 - Nature in which shocks generate fluctuations
 - Conditions that leads to large business cycles volatilities:
(i) "**the size of shocks**", (ii) "**amplification**" and (iii) "**resiliency of the economy**"
 - Policy mitigation