THE POLLUTION HAVEN HYPOTHESIS AND FOREIGN DIRECT INVESTMENT IN MALAYSIA: AN ARDL APPROACH
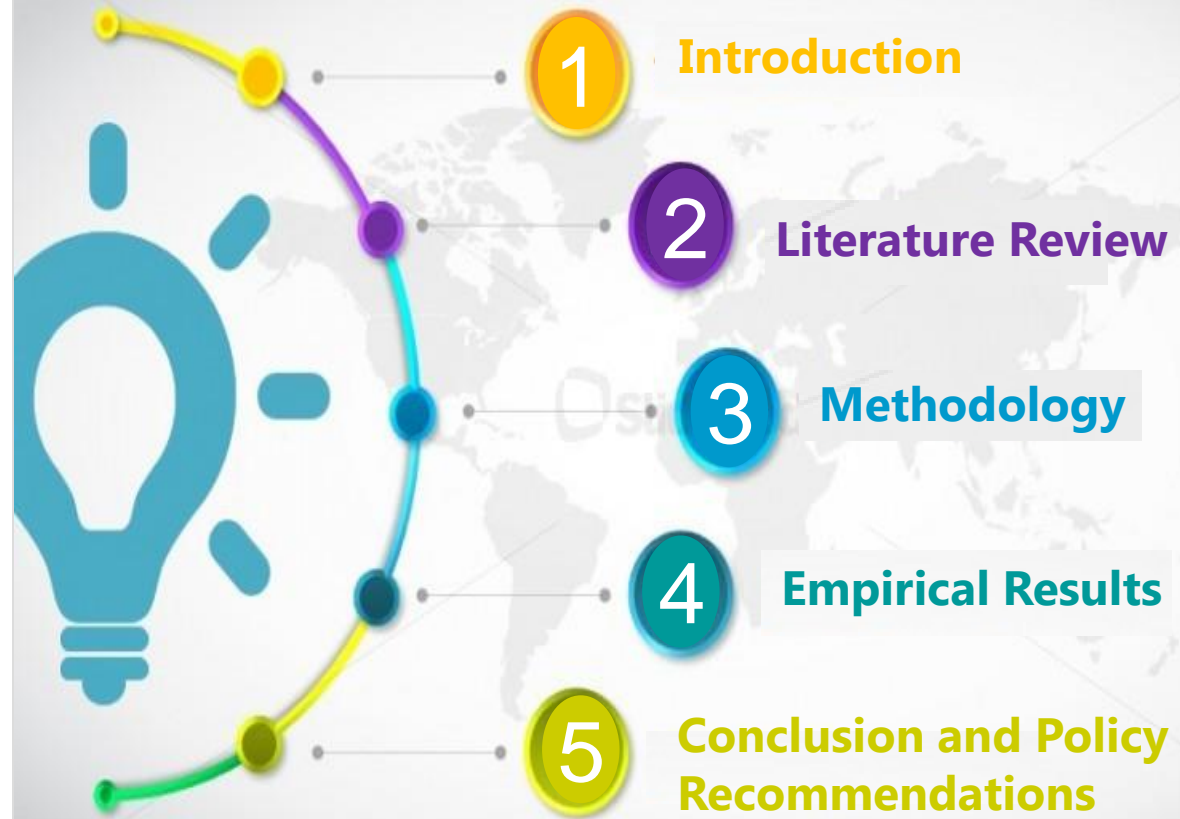
BY:
SUHAILY BINTI SAFIE
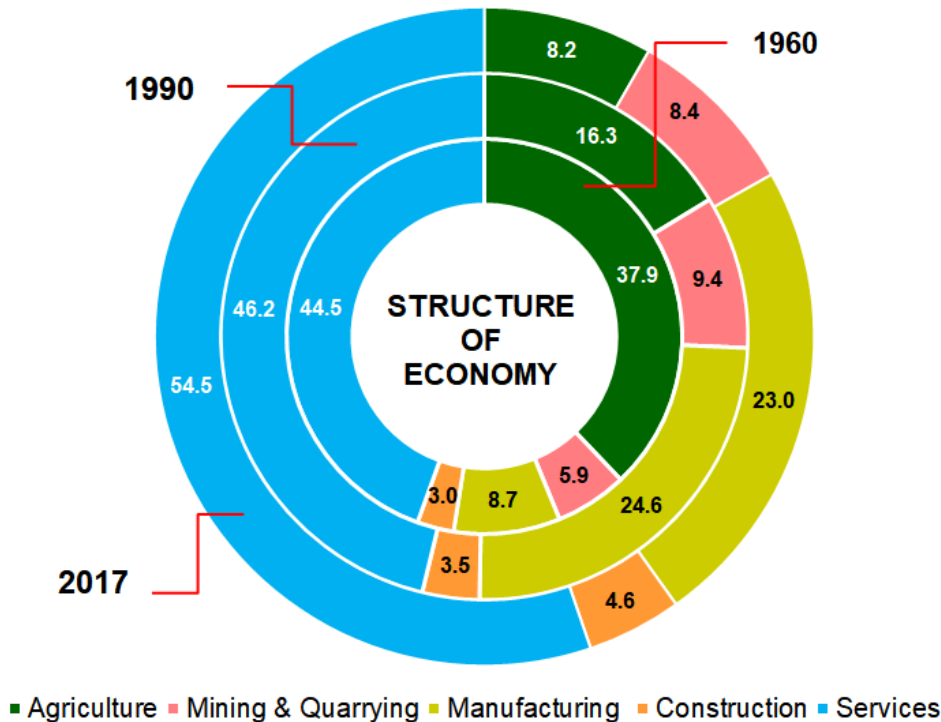
DIVISION:
BALANCE OF PAYMENTS STATISTICS

This paper was submitted to the School of Graduate Studies, University Putra Malaysia, in fulfilment of the requirement for the Degree of Master of Economics

PRESENTATION
OUTLINE

1 Introduction

2 Literature Review

3 Methodology

4 Empirical Results

5 Conclusion and Policy Recommendations

Structure of Economy - Percentage share of GDP (%) for Malaysia

Agriculture ■ Mining & Quarrying ■ Manufacturing ■ Construction ■ Services

Source: Annual Gross Domestic Product, Department of Statistics, Malaysia (various years)

3rd largest economies
In ASEAN in 2017

33rd largest economies
In the world in 2017

23rd out of 137 countries
Global Competitiveness Report 2017/2018

6.4% average economic growth (1970-2016)
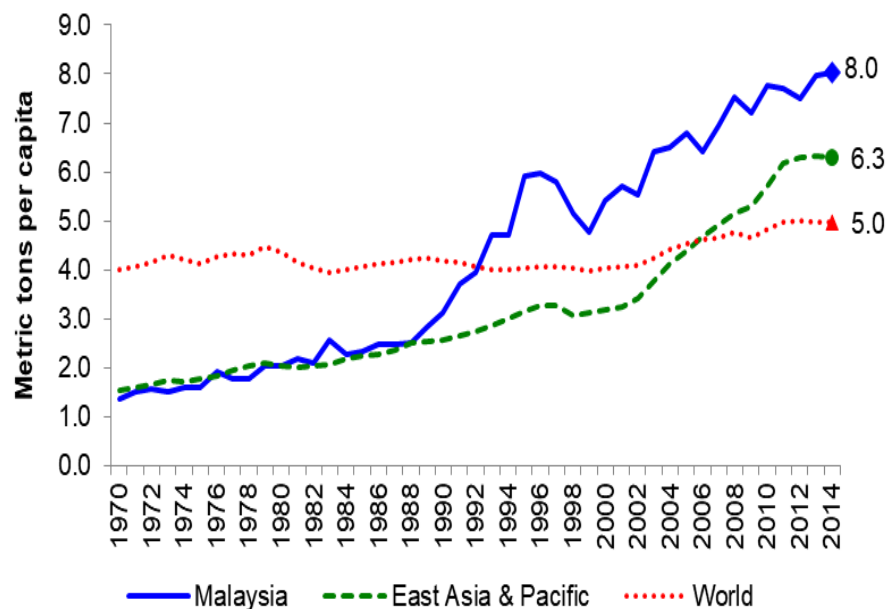World Development Indicators

RM1.17 trillion (2017) from RM0.07 trillion (1970)
GDP (constant 2010 prices)

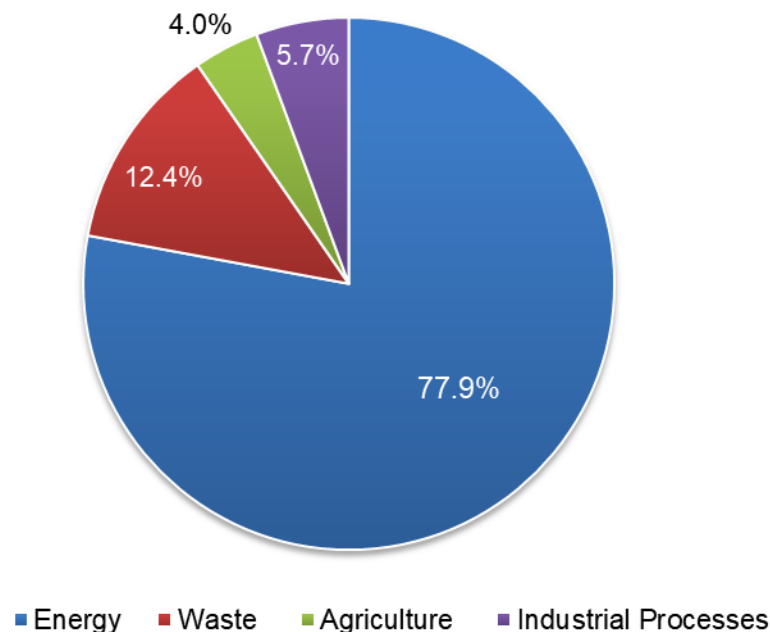**RM1.62 trillion (2017) from RM0.05 trillion (1970)**
Total trade (constant 2010 prices)

**CO2 emissions (metric tons per capita) for Malaysia, East Asia and Pacific and World, 1970 – 2014**

Source: World Development Indicators (databank.worldbank.org)

Key Source of Greenhouse Gas Emissions – Percentage share (%) for Malaysia, 2011

■ Energy   ■ Waste   ■ Agriculture   ■ Industrial Processes

Source: Malaysia Biennial Update Report to the UNFCCC 2015, Ministry Of Natural Resources and Environment Malaysia

CO2 emissions (metric tons per capita) and linear (CO2 metric tons per capita) for Malaysia, 1970 – 2014
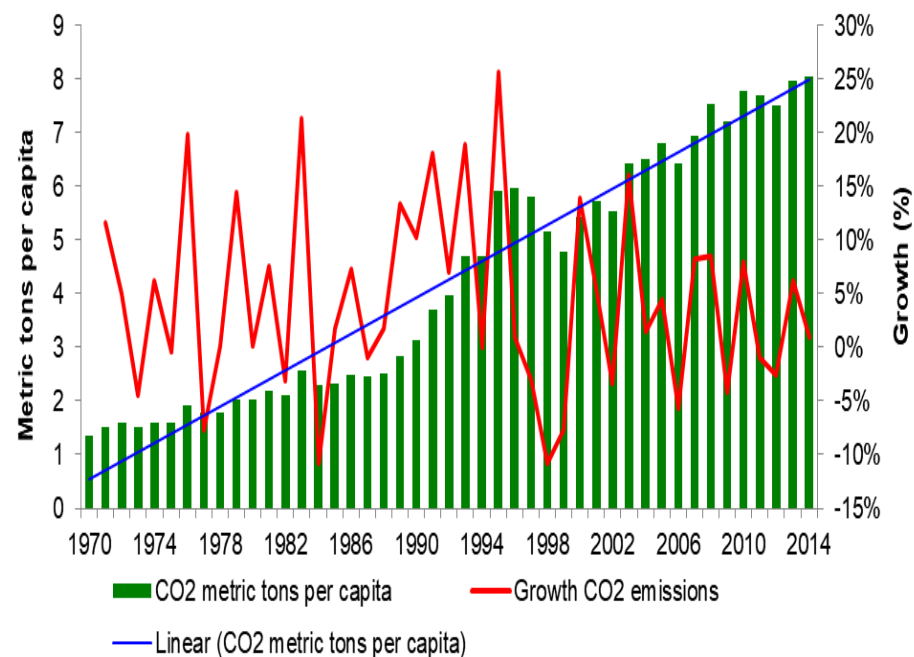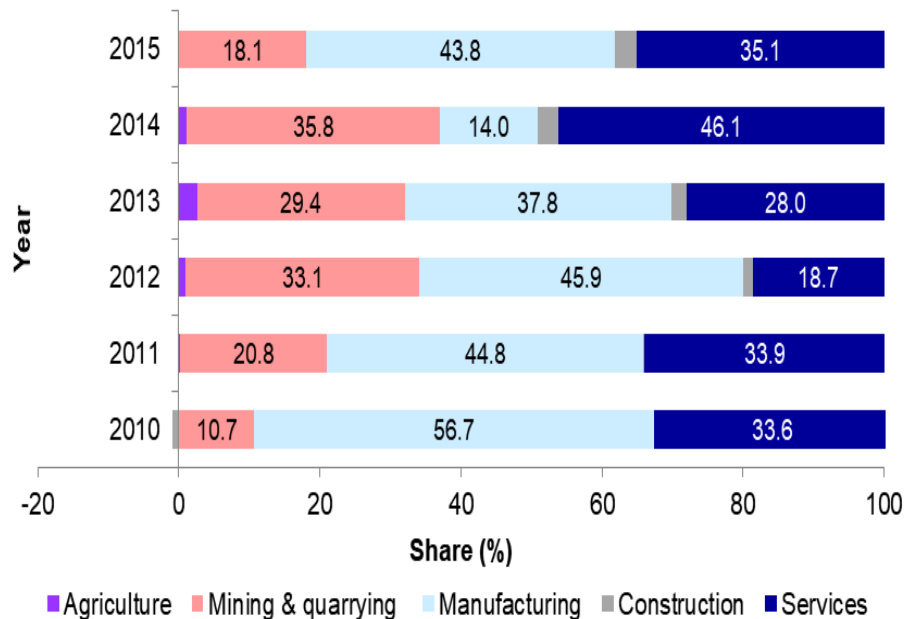

Source: World Development Indicators (databank.worldbank.org)

CO2 emissions (million tons) from fuel combustion by type of fuel for Malaysia, 1971 - 2015
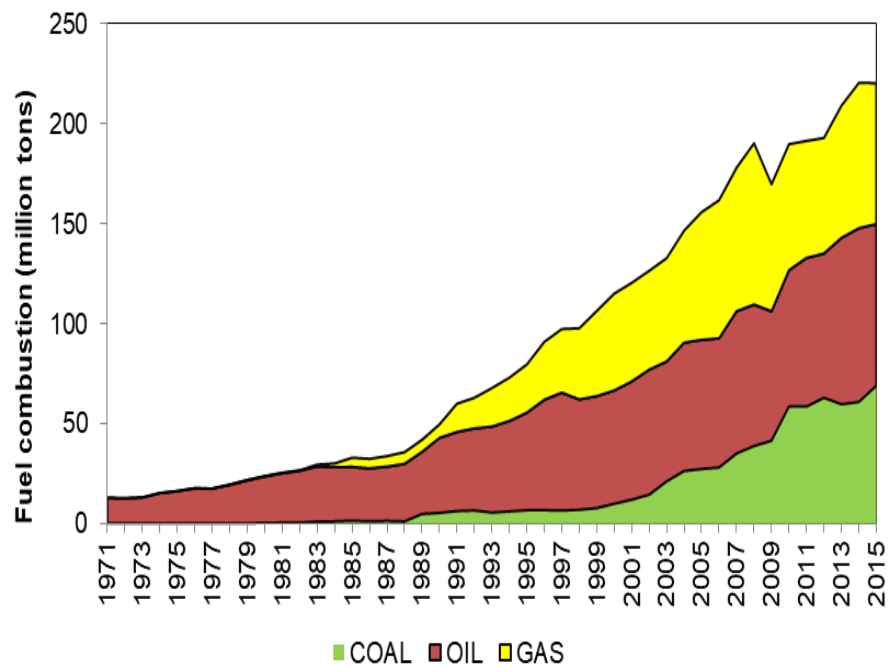
Source: IEA CO2 Emissions from Fuel Combustion, 2017

Net Foreign Direct Investment Flows in Malaysia by Sector, 2010 – 2015

Legend: Agriculture, Mining & quarrying, Manufacturing, Construction, Services

Source: Statistics of Foreign Direct Investment in Malaysia 2016, Department of Statistics, Malaysia

Rural and urban population ('000) for Malaysia, 1970 – 2016

Urban 33.5% (1970)
Urban 49.8% (1990)
Urban 75.4% (2016)

Legend: Rural population, Urban population

Source: World Development Indicators (databank.worldbank.org)

PROBLEM STATEMENT
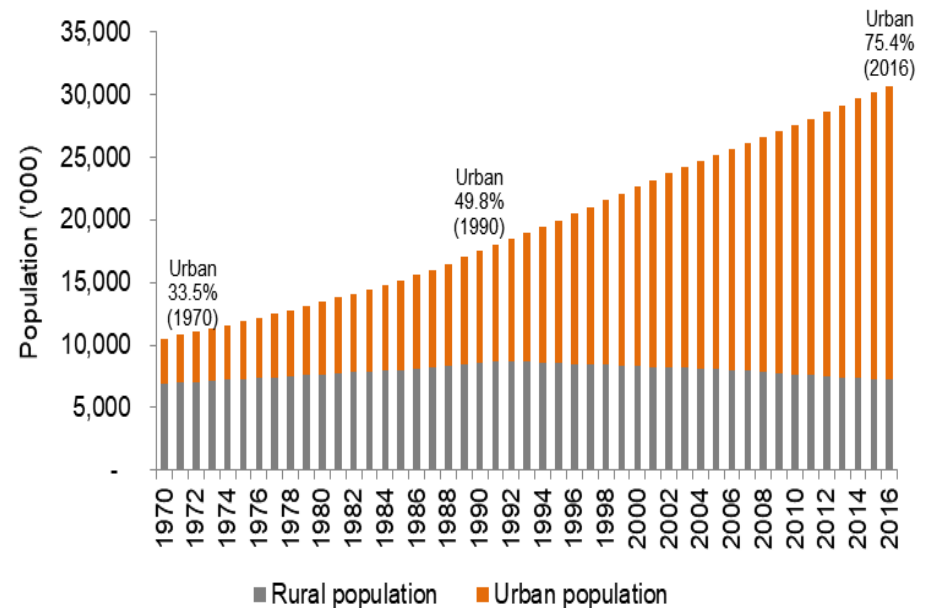
WHAT

Increasing trend in CO_2 emissions, despite Malaysia's commitment to the Kyoto Protocol to cut its emission intensity

WHY

Huge influx of FDI and increase in urbanization rate may lead to the environmental degradation

01 **02**
04 **03**

WHERE

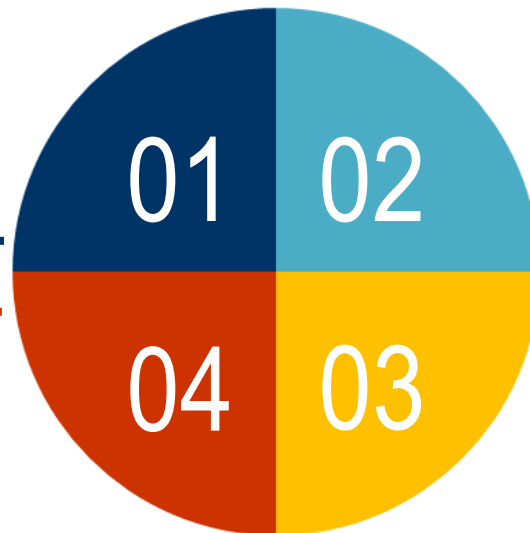Malaysia from year 1970 to 2014

MAGNITUDE

- CO_2 emissions increased from 1.35* (1970) to 8.03* (2014)
- FDI inflow rose from US$0.09 bil. (1970) to US$13.5 bil. (2016)
- Urbanization expanded from 33.5% (1970) to 75.4% (2016)

-WDI, World Bank-

* metric tons per capita

Prior studies examine the relationship between carbon intensity and FDI only without focusing on pollution haven hypothesis

Previous studies

- Investigate pollution haven hypothesis in Malaysia (PHH)
- Recent data
- Extended time series

Gap

Fill the gap by providing analysis on:
- Investigate the existence of PHH in presence of inward FDI
- Examine impact of urbanization

Current study

To determine the relationship between CO_2 per capita emissions and inward foreign direct investment in the long run and short run

SPECIFIC

To examine the possible existence of pollution haven hypothesis (PHH) in presence of inward FDI in Malaysia within the period of 1970 to 2014

To analyze the impact of urbanization on carbon dioxide emissions empirically
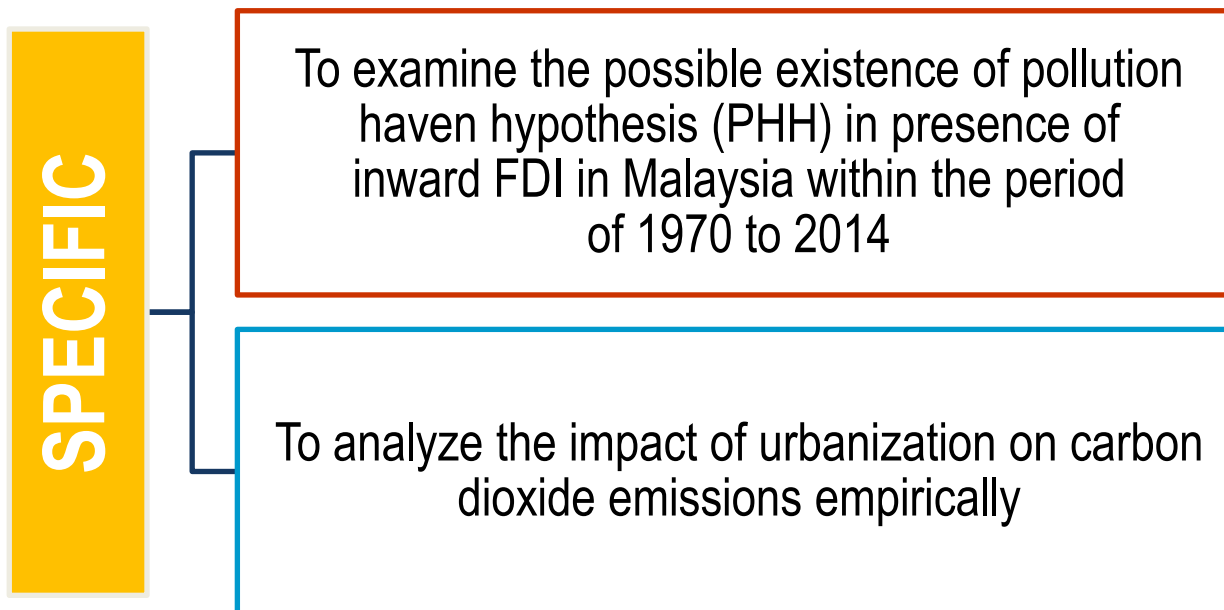
Significance of the Study

▶ Study on PHH is essential for policymakers to effectively improve the environmental standards

▶ Policymakers may mitigate the environmental degradation by observing and choosing less pollutant FDI

▶ Expand further research on impact of urbanization towards CO_2 emissions

Motivation for the Study

Generous investment incentives offered to foreign investment had resulted in large foreign investment inflows ◀

Continuous upward trend of CO_2 emission level ◀

Government endlessly efforts to reduce CO_2 emissions ◀

Although there are quite a number of studies on PHH, there is a lack of research of this hypothesis in Malaysia ◀

REVIEWS ON POLLUTION HAVEN HYPOTHESIS

01

02

REVIEWS ON POLLUTION HAVEN HYPOTHESIS AND URBANIZATION WITH CO_2 EMISSIONS

'The growth in emission of GHG in developing countries reaches the highest during a period when OECD strengthened their environmental regulations' **Birdsall & Wheeler (1992).**

Mani & Wheeler (1998) found a temporary pollution haven effect in an investigation of import-export ratios for dirty industries.

'PHH occurs whenever industrialized nation transfer their polluting industries to developing countries through FDI' **Copeland & Taylor (1994).**

Cole (2004) observes that a pollution haven hypothesis is presence whenever differences in the degree of environmental regulations between developed and developing countries arise.

Elliott & Shimamoto (2008) finds no evidence of the presence PHH in Japanese ASEAN trading countries.

▶ Positive coefficient of **FDI inflow on CO_2 emission** indicates **presence of PHH**

Lau et al. (2014)	: Malaysia
Solarin et al. (2017)	: Ghana
Sun et al. (2017)	: China
Aliyu & Ismail (2015)	: African Countries
Merican et al. (2007)	: ASEAN 5 countries
Chin et al. (2018)	: Malaysia
Hitam & Borhan (2012)	: Malaysia

▶ **GDP on CO_2 emission;**
Hakimi & Hamdi (2017), Al-mulali & Tang (2013)

▶ **Trade openness & CO_2 emission;**
Lau et al. (2014), Solarin et al. (2017) and Sun et al. (2017)

▶ Negative coefficient of **FDI inflow on CO_2 emission** indicates **PHH does not exist**

Al-mulali & Tang (2013)	: GCC
Rafindadi et al. (2018)	: GCC
Zhu et al. (2016)	: ASEAN 5
Shao (2018)	: 188 countries

▶ Insignificant relationship between **FDI inflow** and **CO_2 emission** indicates **PHH not exist**

Ali, Abdullah & Azam (2017): Malaysia
Fereidouni (2013); study on 31 emerging economies over the period 2000-2008

Urban population

Financial development (net domestic credit)

Pollution-financial dev. relationship

- Jalil & Feridun (2011)
- Salahuddin et al. (2015)
- Ali et al. (2017a)
- Shahbaz et al. (2013)
- Dogan & Seker (2016)
- Tiwari & Nasir (2013)

Negative

Impact of urbanization on CO2 emissions

- Zhang et al. (2017)
- Zhang et al. (2014)
- Kasman & Duman (2015)
- Solarin et al. (2017)
- Hossain (2011)
- Shahbaz et al. (2015)
- Farhani & Ozturk (2015)
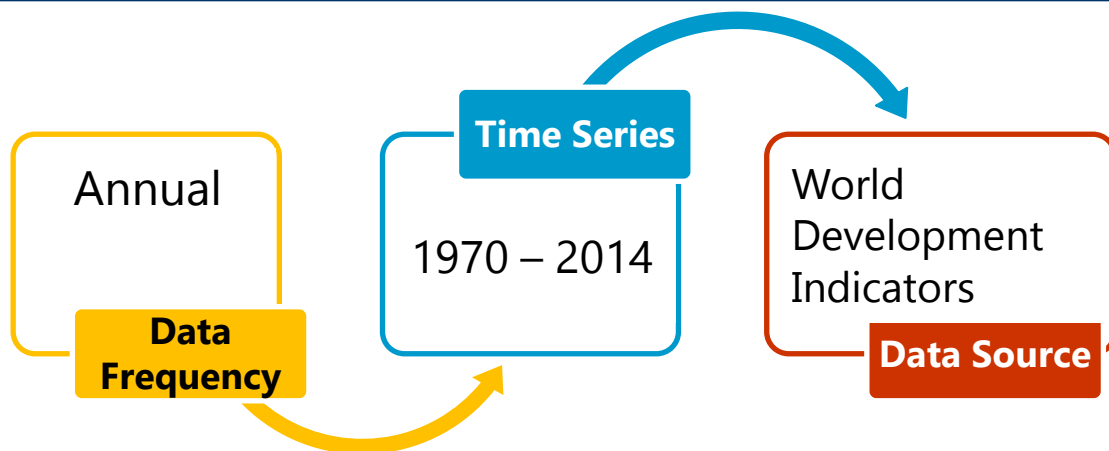- Dogan & Turkekul (2015)
- Shahbaz et al. (2016)

Positive

Economic growth and energy consumption

Pollution-econ. growth-energy used relationship

- Solarin et al. (2017)
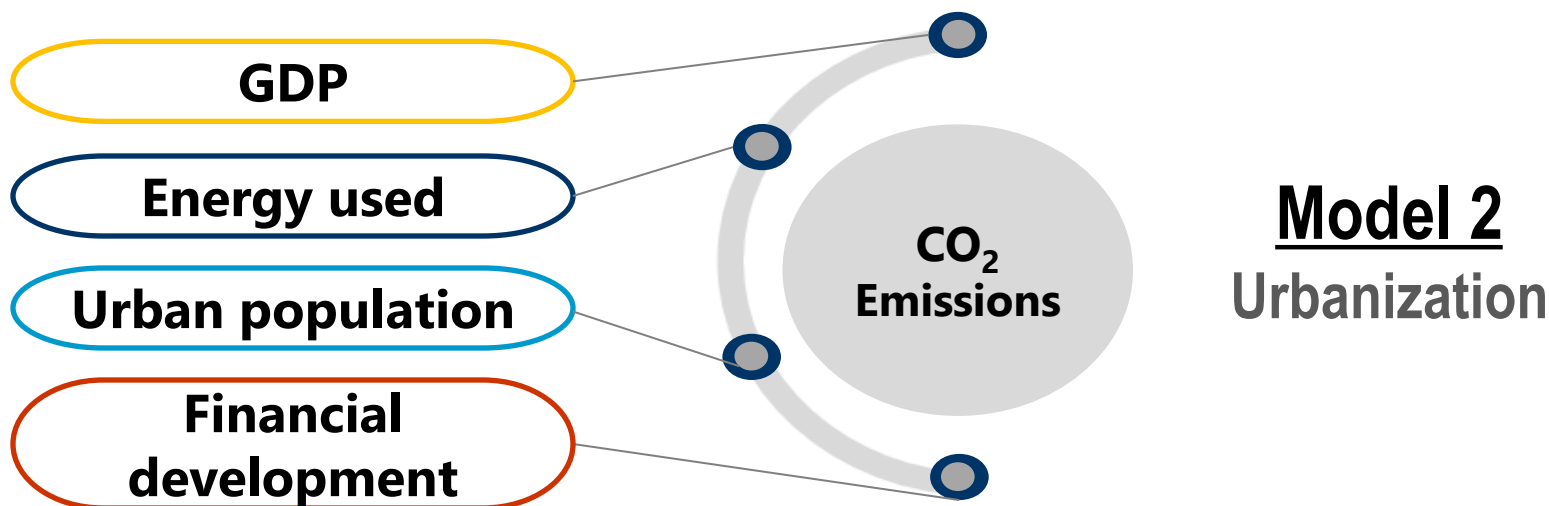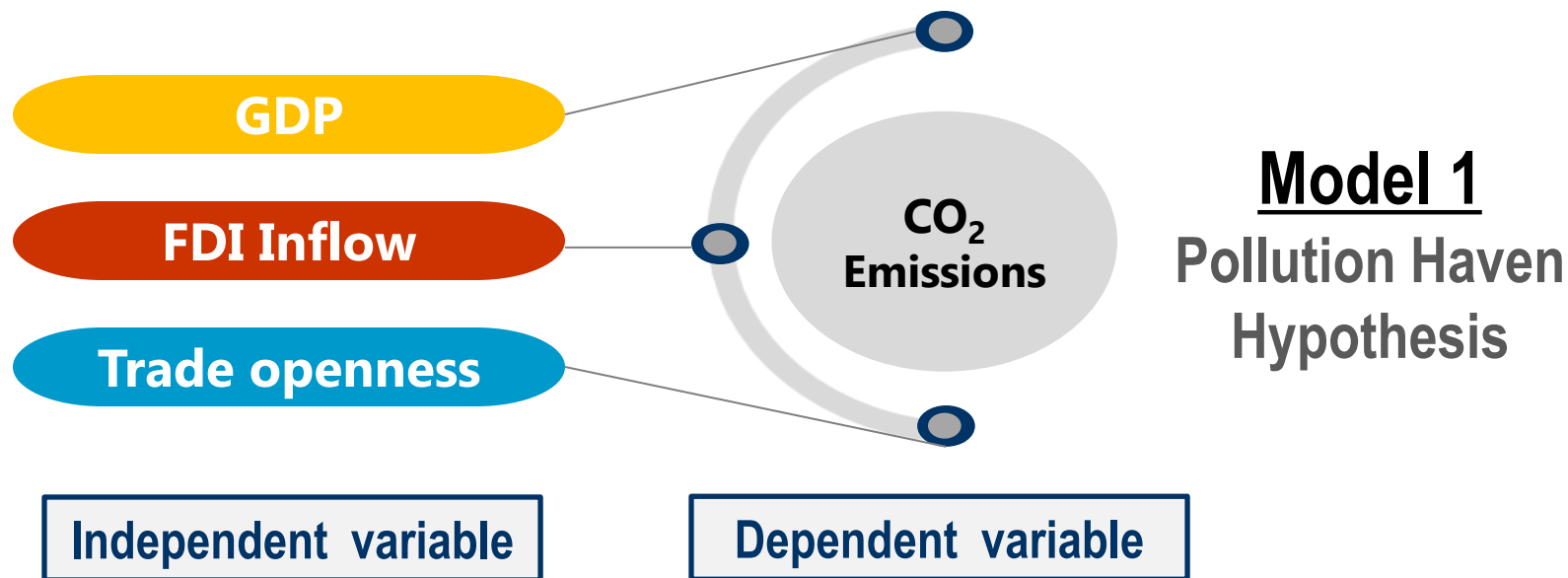- Aliyu & Ismail (2015)

Positive

Annual — **Data Frequency**

Time Series — 1970 – 2014

World Development Indicators — **Data Source**

Variable	Meaning	Unit
Model 1: Pollution haven hypothesis model		
CE_t	CO_2 emissions	metric tons per capita
GDP_t	Gross domestic product	constant 2010 US$ per capita
FDI_t	Foreign direct investment inflow	% of GDP
$TRADE_t$	Sum of imports and exports of goods and services	% of GDP
Model 2: Urbanization model		
CE_t	CO_2 emissions	metric tons per capita
GDP_t	Gross domestic product	constant 2010 US$ per capita
EU_t	Energy use	kg of oil equivalent per capita
UR_t	Urban population	% of growth
NDC_t	Net domestic credit	% of GDP

Autoregressive Distributed Lag (ARDL)

Theoretical Framework

Model Specification

Variables & Data

GDP

FDI Inflow

Trade openness

CO_2 Emissions

Model 1
Pollution Haven Hypothesis

Independent variable

Dependent variable

GDP

Energy used

Urban population

Financial development

CO_2 Emissions

Model 2
Urbanization

Model 1 Pollution Haven Hypothesis	Model 2 Urbanization

Equation 1: Basic form
$CE_t = f(GDP_t, FDI_t, TRADE_t, \varepsilon_t)$

Equation 3: Regression form
$CE_t = \beta_0 + \beta_1 GDP_t + \beta_2 FDI_t + \beta_3 TRADE_t + \varepsilon_t$

Equation 5: Log linear form
$\ln CE_t = \beta_0 + \beta_1 \ln GDP_t + \beta_2 \ln FDI_t + \beta_3 \ln TRADE_t + \varepsilon_t$

Equation 7: ARDL
$$\Delta \ln CE_t = \alpha_0 + \sum_{i=1}^{f} \theta_{1i} \Delta \ln CE_{t-i} + \sum_{i=0}^{f} \theta_{2i} \Delta \ln GDP_{t-i}$$
$$+ \sum_{i=0}^{f} \theta_{3i} \Delta \ln FDI_{t-i} + \sum_{i=0}^{f} \theta_{4i} \Delta \ln TRADE_{t-i}$$
$$+ \beta_{1CE} \ln CE_{t-1} + \beta_{2CE} \ln GDP_{t-1} + \beta_{3CE} \ln FDI_{t-1}$$
$$+ \beta_{4CE} \ln TRADE_{t-1} + \varepsilon_{1t}$$

Expectation:
GDP   : +
FDI Inflow   : +/-
Trade openness : +

Equation 2: Basic form
$CE_t = f(GDP_t, EU_t, UR_t, NDC_t, \varepsilon_t)$

Equation 4: Regression form
$CE_t = \delta_0 + \delta_1 GDP_t + \delta_2 EU_t + \delta_3 UR_t + \delta_4 NDC_t + \varepsilon_t$

Equation 6: Log linear form
$\ln CE_t = \delta_0 + \delta_1 \ln GDP_t + \delta_2 \ln EU_t + \delta_3 \ln UR_t + \delta_4 \ln NDC_t + \varepsilon_t$

Equation 8: ARDL
$$\Delta \ln CE_t = \gamma_0 + \sum_{i=1}^{f} \pi_{1i} \Delta \ln CE_{t-i} + \sum_{i=0}^{f} \pi_{2i} \Delta \ln GDP_{t-i}$$
$$+ \sum_{i=0}^{f} \pi_{3i} \Delta \ln EU_{t-i} + \sum_{i=0}^{f} \pi_{4i} \Delta \ln UR_{t-i}$$
$$+ \sum_{i=0}^{f} \pi_{5i} \Delta \ln NDC_{t-i} + \delta_{1CE} \ln CE_{t-1}$$
$$+ \delta_{2CE} \ln GDP_{t-1} + \delta_{3CE} \ln EU_{t-1} + \delta_{4CE} \ln UR_{t-1}$$
$$+ \delta_{5CE} \ln NDC_{t-1} + \varepsilon_{2t}$$

Expectation:
GDP   : +   Urban population : +/-
Energy used : +   Net domestic credit : +/-

MODEL PROCEDURE

Descriptive Statistics

Identify characteristics of PHH and urbanization models

Unit Root Test

Augmented Dickey-Fuller (ADF) test

Phillips-Perron test

ARDL & Cointegration test

Bound test – Long run relationship

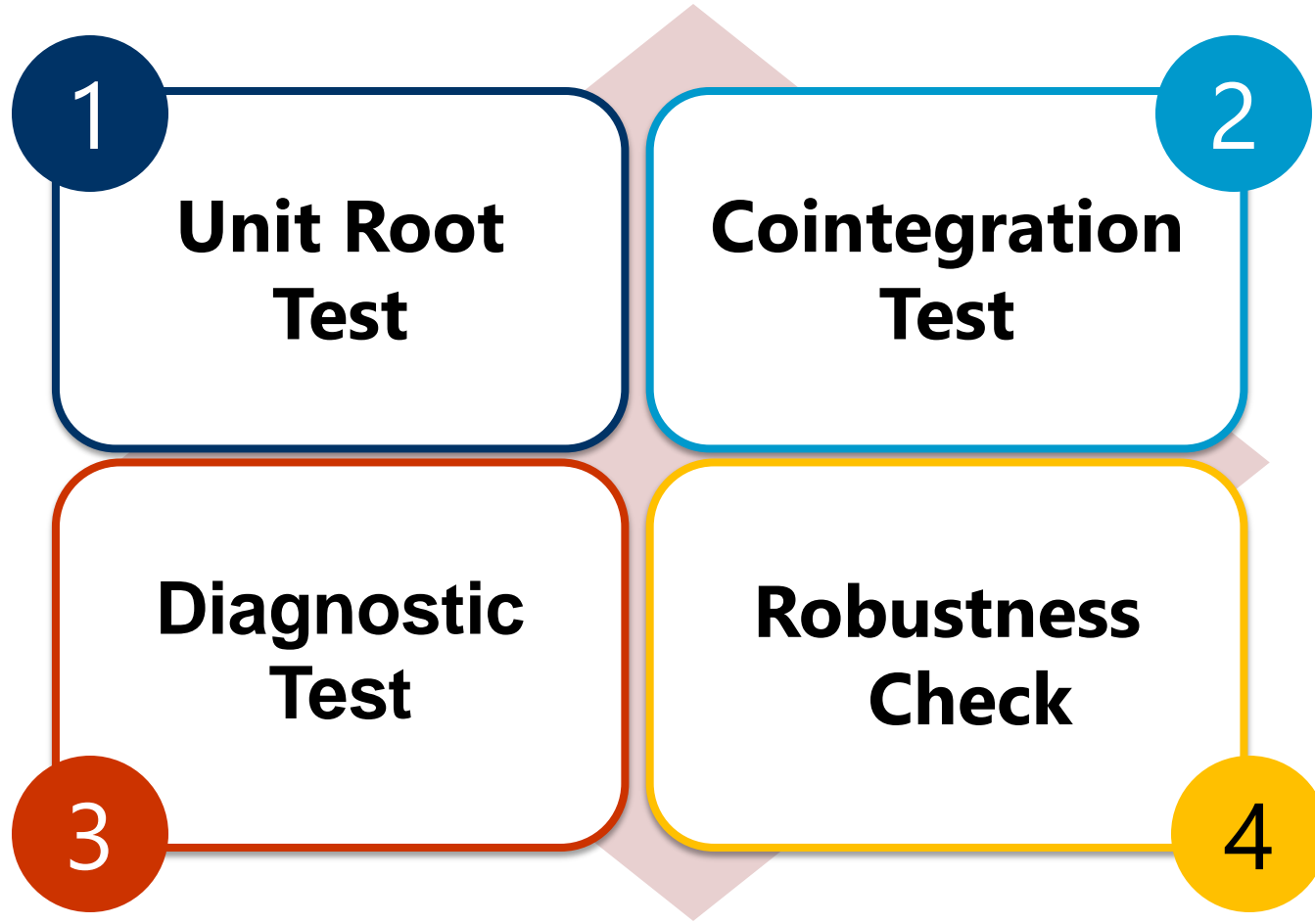Error Correction test – Short run relationship

Diagnostic Test

Residual Test: Normality, Autocorrelation, Heteroscedasticity

Stability Test: Ramsey RESET test, CUSUM and CUSUM SQ

Robustness Check

Fully Modified Ordinary Least Squares (FMOLS)

Dynamic Ordinary Least Squares (DOLS)

1 Unit Root Test

2 Cointegration Test

3 Diagnostic Test

4 Robustness Check

Variable	CO_2	GDP per capita	FDI net inflows	TRADE	Energy use	Urban popula-tion	Net domestic credit
Unit	metric tons per capita	constant 2010 US$	% of GDP	% of GDP	kg of oil equivalent per capita	% of growth	% of GDP
Mean	4.259	5539.573	3.916	144.689	1,585.758	4.153	105.138
Median	3.960	5131.831	3.602	146.888	1,562.131	4.498	114.612
Maximum	8.033	10398.230	8.136	220.407	2,967.541	4.993	163.355
Minimum	1.352	1993.450	1.313	73.668	523.574	2.725	24.116
Std. Dev.	2.285	2524.999	1.552	44.922	802.743	0.719	38.820
Skewness	0.235	0.299	0.870	0.114	0.226	-0.710	-0.621
Kurtosis	1.519	1.792	3.556	1.659	1.629	1.936	2.242
Jarque-Bera	4.526	3.406	6.252	3.470	3.909	5.902	3.973
Probability	0.104	0.182	0.044	0.176	0.142	0.052	0.137
Observations	45	45	45	45	45	45	45

Descriptive Statistics

Correlation Matrix

	CE_t	GDP_t	FDI_t	$TRADE_t$	EU_t	UR_t	NDC_t
CE_t	1						
GDP_t	0.989	1					
FDI_t	0.167	0.144	1				
$TRADE_t$	0.773	0.749	0.312	1			
EU_t	0.987	0.993	0.139	0.780	1		
UR_t	-0.774	-0.812	0.120	-0.401	-0.814	1	
NDC_t	0.697	0.714	0.068	0.747	0.717	-0.390	1

Test/ Variable	Level		First Difference		Order of integration
	Constant	Constant and Trend	Constant	Constant and Trend	
Augmented Dicky-Fuller (ADF)					
$lnCE_t$	-1.003	-2.041	-8.042***	-7.987***	I(1)
$lnGDP_t$	-1.512	-2.047	-5.667***	-5.815***	I(1)
$lnFDI_t$	-3.027**	-2.965	-7.007***	-6.961***	I(1)
$lnTRADE_t$	-1.874	-0.369	-4.961***	-5.455***	I(1)
$lnEU_t$	-0.876	-1.902	-6.901***	-6.917***	I(1)
$lnUR_t$	0.813	-1.077	-5.125***	-5.318***	I(1)
$lnNDC_t$	-3.031**	-2.482	-5.667***	-5.749***	I(1)
Phillips-Perron (PP)					
$lnCE_t$	-1.003	-2.037	-7.985***	-7.977***	I(1)
$lnGDP_t$	-1.512	-2.123	-5.677***	-5.815***	I(1)
$lnFDI_t$	-3.027**	-2.965	-7.009***	-6.965***	I(1)
$lnTRADE_t$	-1.425	0.105	-4.961***	-5.419***	I(1)
$lnEU_t$	-0.999	-1.902	-7.085***	-8.463***	I(1)
$lnUR_t$	0.500	-1.265	-5.119***	-5.318***	I(1)
$lnNDC_t$	-3.177**	-2.463	-5.677***	-5.982***	I(1)

Notes: *** and ** indicate significance at 1% and 5% level

ARDL BOUND TEST AND ECM

Long-run Analysis

Dependent variable = $\ln CE_t$		
Independent Variable	Model 1	Model 2
Long-run coefficients		
$\ln GDP_t$	1.082***	0.871***
	[11.346]	[2.848]
$\ln FDI_t$	0.088	
	[1.239]	
$\ln TRADE_t$	0.161	
	[1.105]	
$\ln EU_t$		0.557**
		[2.100]
$\ln UR_t$		0.461***
		[3.327]
$\ln NDC_t$		-0.235***
		[-3.649]
Constant	-3.815***	-4.212***
	[-20.881]	[-10.246]
R_2	0.986	0.990
Adj. R_2	0.985	0.988
F-statistic	690.899***	731.393***

ARDL Bound Test Results

Test Statistic	Model 1		Model 2	
F-statistic	6.536		9.417	
k	3		4	
Significance	I(0) Bound	I(1) Bound	I(0) Bound	I(1) Bound
10%	2.37	3.20	2.20	3.09
5%	2.79	3.67	2.56	3.49
2.5%	3.15	4.08	2.88	3.87
1%	3.65	4.66	3.29	4.37

ARDL Error Correction Regression Results

Model	Variable	Coefficient	Std. Error	t-Statistic	Prob.
Model 1	CointEq(-1)*	-0.486	0.081	-6.003	0.000
Model 2	CointEq(-1)*	-0.649	0.081	-7.996	0.000

***, ** and * indicate significance at 1%, 5% and 10% levels respectively. [ ] is the t-statistics
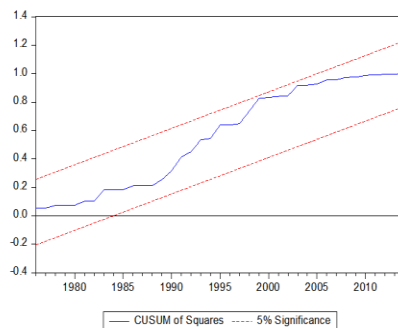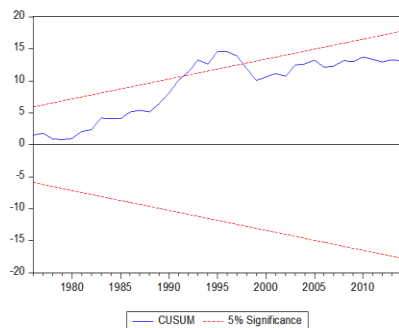
DIAGNOSTIC TEST

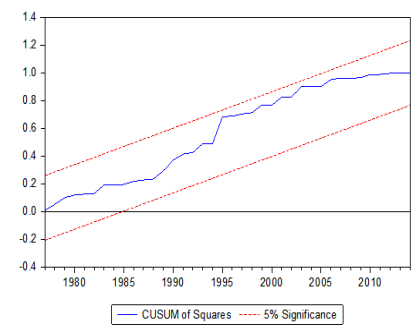| Diagnostic Test	Null hypothesis	Model 1	Model 2
Jarque-Bera	H_0: Residuals are normally distributed	$\chi^2= 0.594$ [0.743]	$\chi^2= 2.874$ [0.238]
Breusch-Godfrey Serial Correlation LM Test	H_0: No serial correlation in residuals	$\chi^2= 0.587$ [0.746]	$\chi^2= 0.053$ [0.974]
Breusch-Pagan-Godfrey	H_0: Homoscedasticity (constant variance)	$\chi^2= 3.602$ [0.463]	$\chi^2 = 5.013$ [0.414]
Ramsey RESET	H_0: Model specification is correct	T-stat= 1.830 [0.075]	T-stat= 1.295 [0.203]

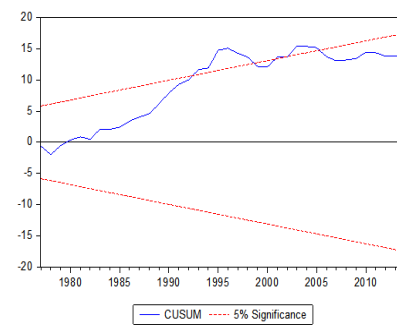### Diagnostic Test Results

- p-value of Jarque-Bera > 0.05. Thus, errors are normally distributed

- No serial correlations in residuals and variance is constant as p-value > 0.05

- Model specifications are well specified as p-value of Ramsey RESET > 0.05

Note: Figures in parentheses [ ] represent probability values of the test statistics.

Plot of CUSUM and CUSUM Square Test
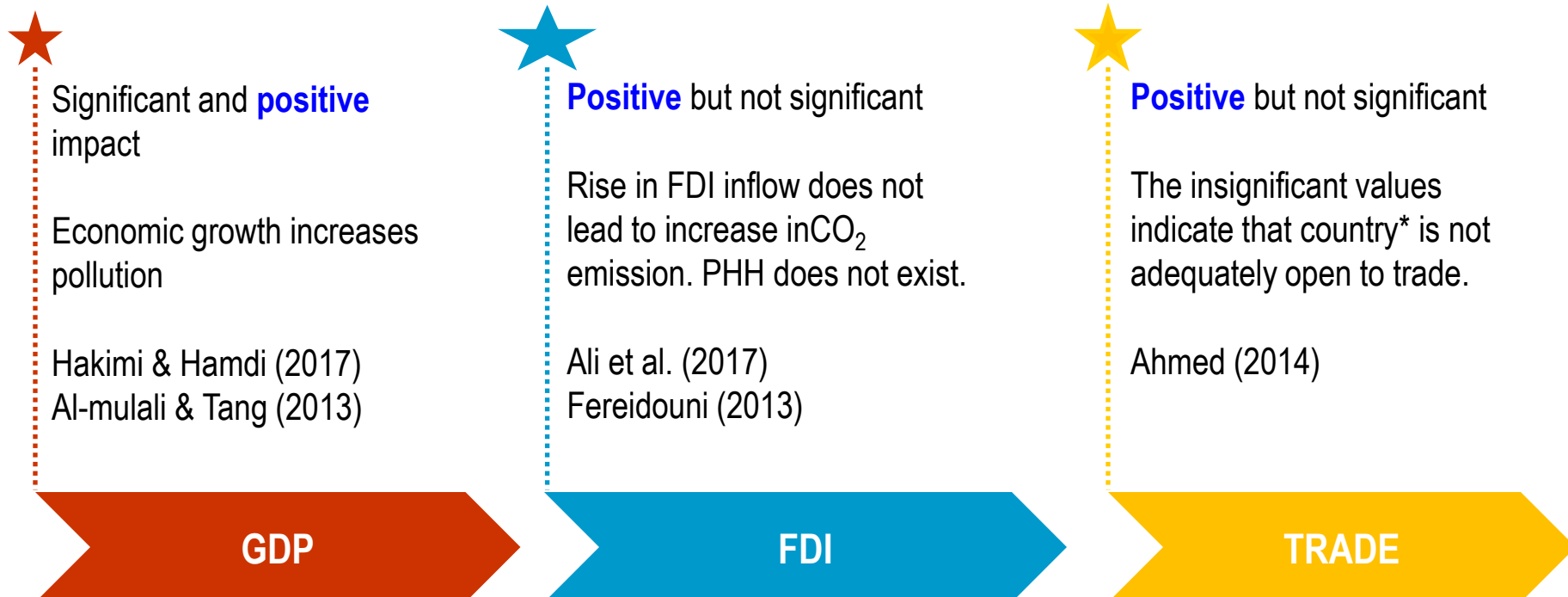

Model 1

Model 2

Independent Variable	FMOLS		DOLS	
Dependent variable = $lnCE_t$				
	Model 1	Model 2	Model 1	Model 2
$lnGDP_t$	1.064***	1.075***	1.095***	1.402***
	[14.523]	[5.252]	[12.380]	[4.024]
$lnFDI_t$	0.044		0.045	
	[0.890]		[0.691]	
$lnTRADE_t$	0.219*		0.229*	
	[1.917]		[1.890]	
$lnEU_t$		0.379**		0.105
		[2.313]		[0.342]
$lnUR_t$		0.499***		0.502***
		[5.091]		[4.114]
$lnNDC_t$		-0.222***		-0.179**
		[-5.025]		[-2.542]
Constant	-3.870***	-4.524***	-4.029***	-4.907***
	[-27.989]	[-15.605]	[-25.742]	[-11.874]
R_2	0.980	0.987	0.988	0.993
Adj. R_2	0.978	0.986	0.982	0.988

Notes: ***, ** and * indicate significance at 1%, 5% and 10% levels respectively.
[ ] is the t-statistics.

Long-run analysis for the **Pollution Haven Hypothesis model**

$$\ln CE_t = -3.815 + 1.082 \ln GDP_t + 0.088 \ln FDI_t + 0.161 \ln TRADE_t$$
$$= (-21.153)^{***} \quad (11.062)^{***} \quad (0.651) \quad (1.465)$$

Notes: *** and ** indicate significance at 1% and 5% levels respectively. [ ] is the t-statistics

Positive but not significant

Significant and **positive** impact

Economic growth increases pollution

Hakimi & Hamdi (2017)
Al-mulali & Tang (2013)

Positive but not significant

Rise in FDI inflow does not lead to increase inCO_2 emission. PHH does not exist.

Ali et al. (2017)
Fereidouni (2013)

Positive but not significant

The insignificant values indicate that country* is not adequately open to trade.
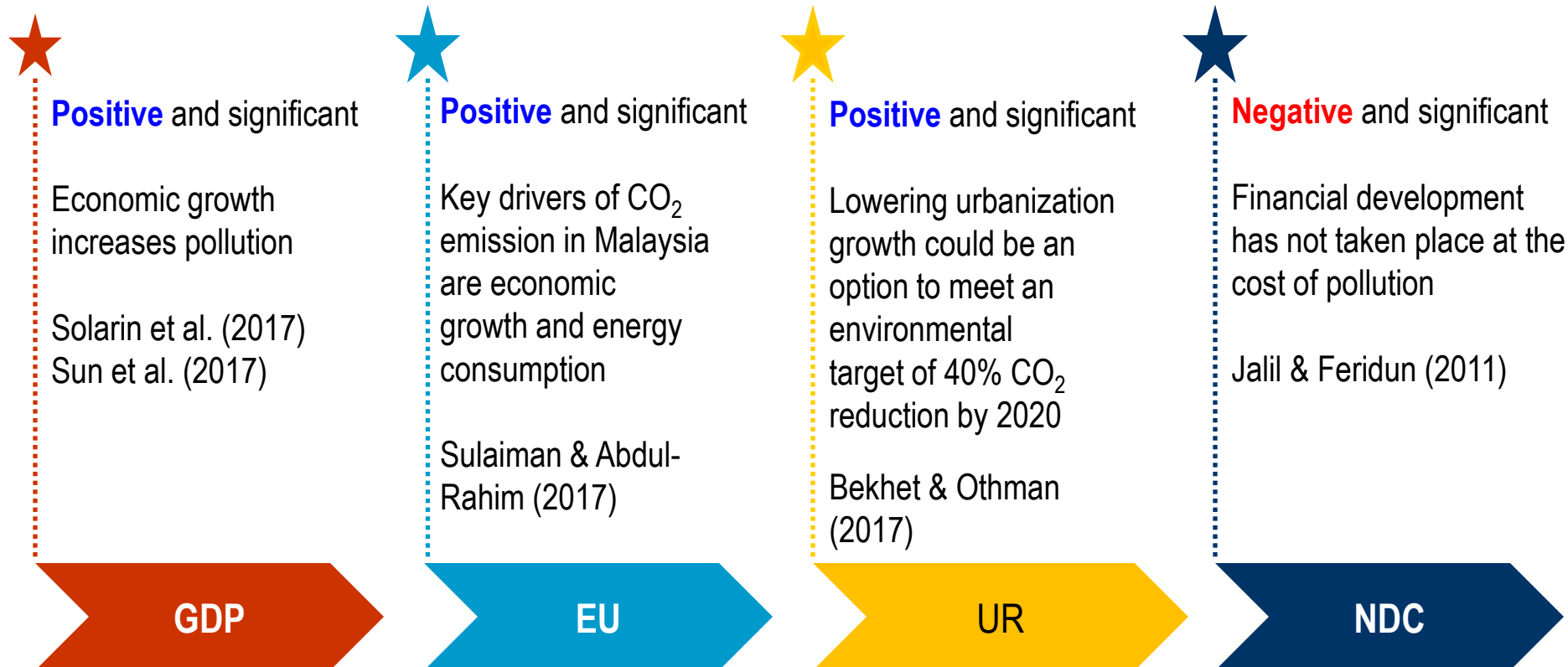
Ahmed (2014)

GDP

FDI

TRADE

Long-run analysis for the **Urbanization model**

$$\ln CE_t = -4.212 + 0.871 \ln GDP_t + 0.557 \ln EU_t + 0.461 \ln URt - 0.235 \ln NDC_t$$

$$= (-10.246)^{***} \quad (2.848)^{***} \quad (2.100)^{**} \quad (3.327)^{***} \quad (-3.649)^{***}$$

Notes: *** and ** indicate significance at 1% and 5% levels respectively. [ ] is the t-statistics

Positive and significant

Economic growth increases pollution

Solarin et al. (2017)
Sun et al. (2017)

GDP

Positive and significant

Key drivers of CO_2 emission in Malaysia are economic growth and energy consumption

Sulaiman & Abdul-Rahim (2017)

EU

Positive and significant

Lowering urbanization growth could be an option to meet an environmental target of 40% CO_2 reduction by 2020

Bekhet & Othman (2017)

UR

Negative and significant

Financial development has not taken place at the cost of pollution

Jalil & Feridun (2011)

NDC

Role of FDI is deteriorating the environment in the long-run but the impact is insignificant

Government should guide MNCs to use the FDI to develop and transfer the green technology

MNCs

FDI

Regulatory bodies
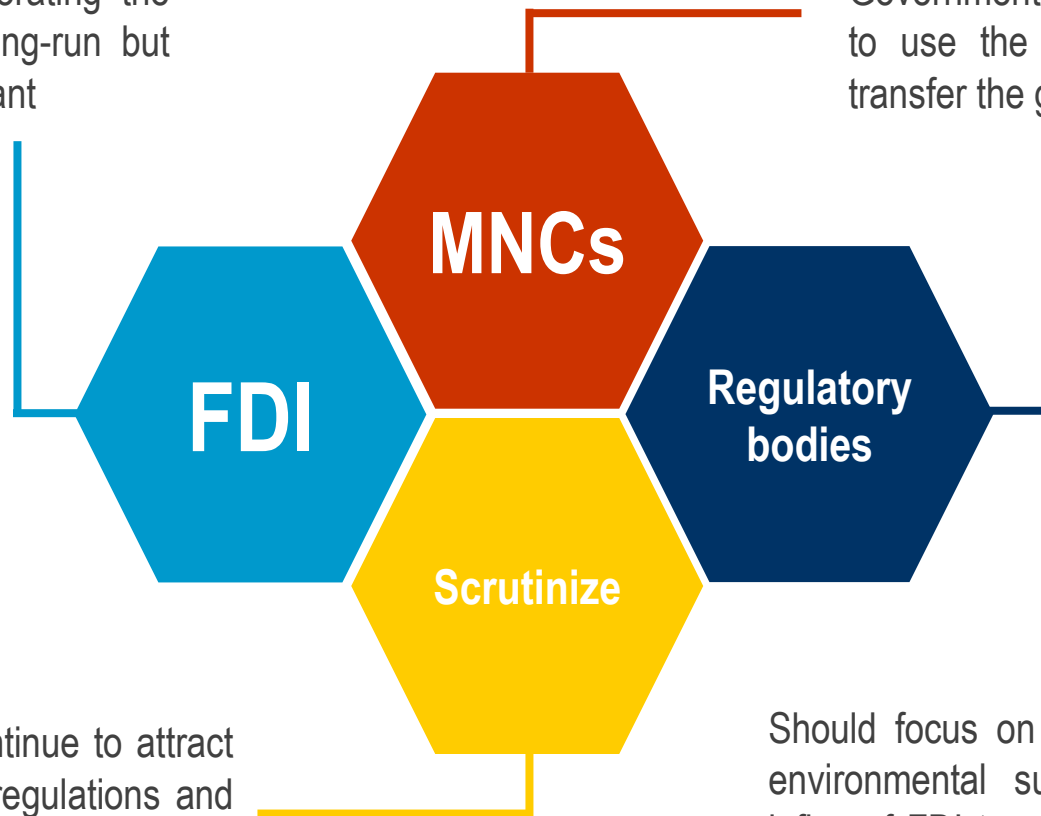
Scrutinize

Malaysia should continue to attract FDI under suitable regulations and firmly scrutinize the inflow of FDI

Should focus on the upgrading of environmental supervision of the influx of FDI to reduce the transfer of pollution in the shape of FDI