Testing the asymmetric and lead-lag relationship between CPI and PPI: an application of the ARDL and NARDL approaches

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Abstract

The purpose of this study is to investigate the asymmetric relationship and lead-lag position between CPI and PPI by comparing with the United State (US), European Union (EU), Singapore and Malaysia. This study supported by previous literature, analyses the time series data using techniques known as ARDL and NARDL. Based on this study of four (4) countries, it is noted that the US Consumer Price Index (UCP) is the most exogenous variable. Accordingly, a focus on US Producer Price Index (UPI) as endogenous has resulted in negative shocks more than positive shocks that could relate to asymmetric price transmission (APT). Thus, when UCP leads UPI, market power in input market responds more rapidly to shocks. Besides, it is also evidenced by the market that technology could hold down inflation and stimulate the GDP by putting pressure on wages, increasing productivity, and encouraging competition. Therefore, mixed approaches can be executed by the policymakers in managing the inflation and PPI to achieve the very best level of a country's economy.

Keywords: Consumer Price index, Producer Price Index, ARDL, NARDL, asymmetric

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INTRODUCTION

Theoretically, inflation is a key concept in macroeconomics, and a major concern for government policymakers, companies, workers and investors. It is related to a broad increase in prices across many goods and services in an economy over a sustained period of time. Whilst, the Producer Price Index (PI), it is a family of indexes that measures the average change in selling prices received by domestic producers of goods and services over time. The PI measures price changes from the perspective of the seller and differs from the CPI, which measures price changes from the purchaser's perspective. The combination of the above could be related to Phillips curve theory whereby it is an economic concept that inflation and unemployment have a stable and inverse relationship.

Therefore, the policymakers need to fully understand the factors and the sources of shock that influence the inflation (Mihailov et al, 2011). The link or causal relationship between Consumer Price Index (CPI) (that represent inflation) and Producer Price Index (PI) based on supply-side and demand-side explanations may reveal relevant policy implications about inflation-control policies.

Many previous study have examined cointegration and causal relationship between these two variables in different countries. However, those studies were based on linear models which assume symmetric adjustments to equilibrium in the error-correction process.

The growing literature that study the effectiveness of monetary policies and the relationship between inflation and Producers Price Index (PI) signify the importance of this issue. Esteve et al. (2006) and Alemu (2012) examined the existence of threshold cointegration between the CPI and the PI in the US and South Africa, respectively, capturing the asymmetric speed of error correcting adjustments and exploring the direction of causality between price indexes in a non-linear framework.

Whilst Ahmed and Cassou (2017), highlighted asymmetric error correction structure shows a significant corrective measure in capacity utilisation during booms while inflation correct during both phases of business cycle which stronger during recessions. In respect of Greece, Evangelia Papapetrou (2001) conveyed VECM's estimation showed that productivity growth and inflation are an econometrically endogenous variable and this suggests that bi-directional causality from inflation to productivity growth and vice versa exists.

Bitros and Panas (2006), the revisited on inflation-productivity trade-off found that the acceleration of inflation from 1964 - 1972 to 1973 - 1980 has reduced total factor productivity growth in a way that was both statistically significant and sizeable. Other study by John B. Taylor (2000), revealed that a significant decline in the degree to which firms "pass through" changes in costs to prices, a decline that is frequently characterized as a reduction in the pricing power of firms.

From the above literature, it is clear that the empirical evidences have found a mixed and inconclusive results, depending on the study period, country and methodology used. Therefore, this paper would be another attempt to the growing literature on the inflation link to producer price index by using a more advanced technique, namely ARDL and NARDL. An asymmetry relationship will be tested from a long time series data employed; and accordingly, the results and findings would have impact on policymakers' decision.

In terms of data and methodology, this study utilises monthly data extracted from Datastream for a period from Jan 2009 to September 2018 based on four (4) countries namely the United States, European Union, Singapore and Malaysia with three (3) variables for each country namely Consumer Price Index (represent Inflation), Producer Price Index and Interest rate. The methodology used in this study combines standard time series techniques, autoregressive distributed lags model (ARDL) and non-linear ARDL (NARDL). The reduction of variables to eight (8) has occurred at the co-integration test was due to the maximum variables can be tested only up to ten (10 variables); thus interest rate has been excluded from each country analysis.

For step no. 1, the unit root tests will be conducted on the level and differenced forms of the variables. This step requires all variables to be non-stationary. There are three (3) tests will be conducted including Augmented Dickey-Fuller (ADF), Phillips-

Perron (PP) and KPSS tests. ADF test (Dickey and Fuller, 1979) takes care and correcting autocorrelation only whilst PP test (Phillips and Perron, 1988) takes care of both autocorrelation and heteroscedasticity. The null hypothesis of both tests is there is non-stationary. On the other hand, KPSS use null hypothesis of there is co-integration between the variables (Kwiatkowski et al., 1992), i.e. the variables are stationary. The results for all three (3) test above are mixed at log and 1st difference form. Therefore, this study cannot proceed with Engle-Granger or Johansen co-integration tests as they require all variables to be non-stationary. The ARDL will be used in the later section, since it does not require all variables to be non-stationary, to identify whether there is long run relationship between the variables. Nevertheless, this study will use the ADF and PP tests at this juncture to enable carrying out Engle-Granger and Johansen tests.

Step no. 2 - Vector autoregression (VAR) order selection (VAR) will be performed to determine the optimum number of lag for variables used in the study. In respect, given the table of selection criteria based on Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC), the no. of lags or order of VAR is two (2).

From VAR, the result will be used in Johansen co-integration test (Johansen) (Step no. 3) to identify the exact number of co-integrating vectors between the variables and it is based on maximum likelihood (Johansen, 1991). Results show that both from maximal eigenvalue and trace table have co-integration at Lag order 2, Unrestricted intercept and trend, but with different no. of co-integration. Therefore, all variables may have long term relationship in this respect. Next, this study will proceed with co-integration test using ARDL (step no. 4).

Step no. 4 will proceed with ARDL technique, a more advanced technique compared to the standard time series which is introduced by Pesaran et al. (2001) i.e. is a bound testing approach that can be used even for small sample size. It comprises of two (2) main stages. The first stage will be testing of the long run relation between the variables by computing the F-statistic for testing the significance of the lagged levels of the variables in the error correction form of underlying ARDL model. The calculated F-statistic will be compared against the upper and lower critical values as determined by Pesaran et al. (2001).

The test result shows that F-statistics for the United States Producer Price Index (USPI), European Producer Price Index (EUPI) and Singapore Consumer Price Index (SCPI) recorded at 3.8951, 4.6238 and 4.5727 respectively is higher than the upper bound critical value of 3.746 (95% interval) and 3.383 (90% interval). Therefore, the null hypothesis can be rejected and it can be concluded that there is a long run relationship for USPI, EUPI and SCPI; and the relationship is not spurious. Since the above has at least one has co-integration i.e. the advantage of ARDL, there is theoretical link between the variable, thus this paper will then proceed to VECM to identify the causality and Non-linear ARDL (NARDL) to conclude the linear and non-linear co-integration while differentiating the short and long run effects.

The next step no. 5 namely Vector Error Correction Method (VECM) will continue where error correction term is estimated to determine whether a variable is exogenous or endogenous but it does neither tell the relative strength nor rank the variables. The results show that the United States Consumer Price Index (UCP) is the only exogenous based on Akaike Information Criterion (VAIC) criteria while under Schwarz Bayesian Criterion (VSBC), the UCP and Singapore Consumer Price (SCP) are exogenous; or in short they are controlled by external factors. Both are considered intuitively relevant in general term as both are dominant features in economy markets i.e. world market for both variables and for SCP which influence by the Asian market too.

As the long run relationship holds, the next step no. 6 will be non-linear ARDL (NARDL), amore advance technique introduced by Shin et al. (2014). The NARDL does not assume linearity or symmetric adjustment. It enables testing linear and non-linear co-integration while differentiating the short run and long run effects of regressors to the dependant variable. Hence, for the purpose of NARDL, focus will be only the United States Consumer Price Index (CPI) and its Producer Price Index (PI) as exogenous and endogenous respectively. This is to determine whether CPI could control PI and to know whether the long run relationship exist between these two variables (UCP and UPI), and whether the relationship is linear or non-linear.

Based on NARDL test, it shows significant results i.e. F-stat 7.46 is more than upper bound between 5.109 to 5.872 at 90% level (as per Table B.1 – Case III: Intercept and trend). There is significant long run asymmetry, also significant short run asymmetry on 90% level. In the long run, if increase the independent variable i.e. UCP by 1%, the dependant i.e. UPI increase by 1.979%. And when UCP decreases by 1%, the dependant variable decrease by 5.9 percent. For model diagnostic, due to p-value is more than 5%, there is no autocorrelation, heteroscedasticity and misspecification on non-normality in the model.

In addition, based on the plot bootstrap of NARDL; the cumulative effect on LUCP on LUPI is negatively asymmetrical. It reacts to negative shocks more than positive shocks. Therefore, when the price of goods and services is increase, the producer price index will increase in smaller proportion compared to when the price of good and services are reduced.

The above asymmetrical movement could relate to asymmetric price transmission (APT) which can be attributable to many factors. Market power is one of the major explanations of APT (Deltas, 2008; Peltzman, 2000). As the CPI leads to PI it might be explained by the market power in input markets when the sellers of PI input resources respond more rapidly to shocks to CPI inflation that increase derived demand for inputs than those diminish it. Moreover, wage rigidity and price inflexibility in retail and input markets may lead to APT (Caporale et al., 2002).

Based on the above, the policymakers are facing the dilemma in managing the economy at all time. The effectiveness of economic structure either fiscal or monetary policy could sometime digress or not meeting the desired “dual mandate” for price stability and maximum employment as happened in the United States. Moreover, theoretical and practically ways in managing the economy should address options and mixed approaches in achieving the best economy. Accordingly, as it is noted that the US Consumer Price Index (UCP) is the most exogenous variable and its Producer Price Index (UPI) as endogenous has resulted in negative shocks more than positive shocks, market power in input market need to “handle with care”.

Therefore, in order to control inflation, the policymakers should also introduce more competition into the retail and input markets. Many empirical studies have suggested that market power can lead to asymmetric price transmission (APT) but there are still other factors leading to APT, which include adjustment or menu costs

(Levy et al.,1997; Dutta et al., 1999), inventory management (Blinder, 1982) as well as costs of stockouts and search costs (Loy et al., 2016). The link between market power and APT is therefore theoretically ambiguous (Meyer and Cramon-Taubadel, 2004). Future research needs to be taken on the causes of APT on specific markets related to areas of production namely industry-based, commodity-based and commodity-based final demand-intermediate demand.

Besides, it is also evidenced by the market that technology could hold down inflation and stimulates the GDP thru PI by putting pressure on wages, increasing productivity, and encouraging competition. Therefore, mixed approaches to execute by the policymakers in managing the inflation and PI to achieve at the very best level of country's economy.

In the following sections of this paper are organised as follows: Section 2 describes the theoretical underpinnings of Consumer Price Index (CPI) (inflation) and Producer Price Index (PI); Section 3 provides the empirical evidences of prior literatures; Section 4 outlines the data and methodology used in this study; Section 5 deliberates on the results and the economic interpretation; while Section 6 concludes with policy implications and limitations as well as suggestion for further research.

THEORETICAL UNDERPINNINGS

Theoretically, inflation is a key concept in macroeconomics, and a major concern for government policymakers, companies, workers and investors. It is related to a broad increase in prices across many goods and services in an economy over a sustained period of time. It is also conveyed as the erosion in value of an economy's currency (a unit of currency buys fewer goods and services than in prior periods[1]). In the United States, the Consumer Price Index (CPI) refers to inflation also called as "market basket" of goods to measure the changes in prices experienced by average consumers in the economy.

For the Producer Price Index (PI), it is a family of indexes that measures the average change in selling prices received by domestic producers of goods and

[1] https://www.investopedia.com/university/macroeconomics/macroeconomics6.asp

services over time. The PI measures price changes from the perspective of the seller and differs from the CPI, which measures price changes from the purchaser's perspective. The PI considers three areas of production: industry-based, commodity-based and commodity-based final demand-intermediate demand. It was known as the wholesale price index, or WPI, until 1978.

The combination of the above could be related to Phillip curve theory whereby it is an economic concept that inflation and unemployment have a stable and inverse relationship. The theory claims that with economic growth comes inflation, which in turn should lead to more jobs and less unemployment. Therefore, I opined that economic growth could increase the production price (in general). However, the original concept has been somewhat disproven empirically due to the occurrence of stagflation in the 1970s, when there were high levels of both inflation and unemployment[2].

Therefore, the policymakers need to fully understand on the factors and the sources of shock that influence the inflation (Mihailov et al, 2011). The link or causal relationship between Consumer Price Index (CPI) (that represent inflation) and Producer Price Index (PI) based on supply-side and demand-side explanations may reveal relevant policy implications about inflation-control policies.

Accordingly, supply side is related to input in the production of the final good sold to final consumers. Any shock to prices at the beginning of production stage via production chain, will result in transmitting the prices of processed goods at later stages to ultimately translated to consumer prices. This pass-through mechanism represents the causality from PI to CPI. Clark (1995) provides a brief summary of the production chain theory but points out that the pass-through effect from the PI to the CPI may be weakened by some other factors such as the offsetting changes in prices of imported materials, productivity gains, and changes in the mark-up of the product price over cost.

[2] https://www.investopedia.com/terms/p/phillipscurve.asp

Whilst for demand side, Colclough and Lange (1982) costs of production reflect the opportunity costs of resources and intermediate materials among competing uses, and it is the demand for final goods and services that determines the costs of production. This suggests that the CPI leads the PI, and implies that the government authorities should seek to gain control over the demand-pull factors that drive the CPI, which would be helpful for controlling the propagation of inflation from the retail to the input sectors. Caporale et al. (2002) also argue that the CPI may affect the PI through the labor supply channel if wage earners in the input sectors want to protect the purchasing power of their income.

Many previous study have examined cointegration and causal relationship between these two variables in different countries including but not limited to Caporale et al. (2002), Ghazali et al. (2008), Shahbaz et al. (2009), Shahbaz et al. (2010), Sidaoui et al. (2010), Akçay (2011) and Tiwari and Shahbaz (2013). However, those studies were based on linear models which assume symmetric adjustments to equilibrium in the error-correction process.

In the United States, the economy has been recovering slowly yet unevenly since the depths of the recession in 2009. The economy has received further support through expansionary monetary policies. This includes not only holding interest rates at the lower bound, but also the unconventional practice of the government buying large amounts of financial assets to increase the money supply and hold down long term interest rates, a practice known as "quantitative easing". While the labour market has recovered significantly and employment has returned to pre-crisis levels, there is still widespread debate regarding the health of the US economy.

For European Union, a tightening labour market and solid investment should strengthen activity next year (2019). However, less accommodative monetary policy and slower global trade will cause growth to slow, while rising global protectionism and turbulent internal politics remain the key risks to the bloc's forecasts. The projects growth of 1.7% in 2019, which is down 0.1 percentage points from last month's forecast, and 1.6% in 2020, whilst inflation is seen remaining moderate both next year and in 2020. Thus, it sees harmonized inflation averaging 1.7% in 2019 and in year 2020, inflation is seen broadly stable at 1.6%.[3]

For Singapore, the government keeps a close watch on consumer price developments from both imported and domestic inflation and undertakes several measures to mitigate them. This is due to some of the components of CPI are affected by the cost of imported goods (e.g. food), while some are affected by domestic cost pressures. The main drivers of Singapore's high inflation today are domestic cost pressures, which stem from supply side conditions. Imputed rentals on owner-occupied accommodation (OOA) have been increasing on the back of a tight housing market. However, imputed rentals on OOA have no cash impact on households who already owned their homes.

Whilst in Malaysia, the inflation has picked up to 0.6% in October 2018, doubling September's result due to the effects of the reinstatement of the sales and services tax (SST) on 1 September, three months after the goods and services tax (GST) was zero-rated on 1 June. Annual average inflation edged down to 1.5% from 1.8% in September. Lastly, core inflation which excludes certain types of fresh food and administered prices of goods and services inched up to 0.4% in September from 0.3% in the previous month. The expected inflation to average 2.2% in 2019 and 2.4% in 2020.[4]

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[3] https://www.focus-economics.com/regions/euro-area

[4] https://www.focus-economics.com/countries/malaysia/news/inflation/inflation-picks-up-in-october-following-the-reinstatement-of-the

LITERATURE REVIEW

The growing literature that study on the effectiveness of monetary policies and the relationship between inflation and Producers Price Index (PI) signify the importance of this issue. Esteve et al. (2006) and Alemu (2012) examined the existence of threshold cointegration between the CPI and the PI in the US and South Africa, respectively, in a threshold vector error correction model (TVECM), which has the advantages of capturing the asymmetric speeds of error correcting adjustments and exploring the direction of causality between price indexes in a non-linear framework.

Ahmed and Cassou (2017), an analogue to the Philips curve that shows a positive relationship between inflation and capacity utilisation had eventually breached the rules after mid-1980s. In the long run, inflation increase to 1% has resulted in 0.0046% increase in capacity utilisation. However, in the short run, the changes in inflation rate do Granger cause to capacity utilization but not vice versa. This asymmetric error correction structure shows a significant corrective measure in capacity utilisation during booms while inflation correct during both phases of business cycle which stronger during recessions.

Evangelia Papapetrou (2001), in the case of Greece between the period 1962 – 1997, VECM estimation showed that productivity growth and inflation are an econometrically endogenous variable and this suggests that bi-directional causality from inflation to productivity growth and vice versa exists.

Bitros and Panas (2006), the revisited on inflation-productivity trade-off found that the acceleration of inflation from 1964 - 1972 to 1973 - 1980 has reduced total factor productivity growth in a way that was both statistically significant and sizeable. The direction of causality between these two variables also emerged the great majority of two digits manufacturing industries runs from inflation to productivity. Accordingly, the inflation-productivity trade-off prevails stability of their relationship in the long run.

Other study by John B. Taylor (2000), revealed that a significant decline in the degree to which firms “pass through” changes in costs to prices, a decline that is frequently characterized as a reduction in the "pricing power of firms. The decline appears to be associated with the decline in inflation in many countries. Therefore, through its monetary policy, the policy maker needs to revisit the cost structure of the firm and also intensify the market to control the inflation amicably.

Based on the above, it is clear that the empirical evidences have found a mixed and inconclusive results, depending on the study period, country and methodology used. Therefore, this paper would be another attempt to growing the literature on the inflation link to producer price index by using a more advanced technique, namely ARDL and NARDL. An asymmetry relationship will be tested from a long time series data employed; and accordingly, the results and findings would have impact on policymakers' decision.

DATA AND METHODOLOGY

This study utilises monthly data extracted from Datastream for a period from Jan 2009 to September 2018 based on four (4) countries with three (3) variables each as follows:

i. United States of America (USA)

Variable	Symbol	Proxy
Consumer Price Index (represent Inflation)	UCP	All Urban Consumers, United States City Average, Consumer Prices, All Items, SA, Index, 1982-1984 = 100
Producer Price Index	UPI	Production, Overall, Total, SA, Index, 2012 = 100
Interest rate	UIN	Treasury Bill Rate - 3 Month (EP)

ii. European Union (EU)

Variable	Symbol	Proxy
Consumer Price Index (represent Inflation)	ECP	Expenditure Approach, Gross Domestic Product, Total at Market Prices (Changing Composition), ESA2010, Constant Prices, Calendar Adjusted, SA, Euro, 2010 Chained Prices
Producer Price Index	EPI	Production, Manufacturing, Nace Rev 2 C, EA19, SA, Index, 2015 = 100

Interest rate	EIN	European Monetary Union, Euro Interbank Offered Rate - 3-Month

iii. Singapore (SG)

Variable	Symbol	Proxy
Consumer Price Index (represent Inflation)	SCP	Consumer Prices, All Items, Index, 2014 = 100
Producer Price Index	SPI	Production, Manufacturing, Index, 2015 = 100
Interest rate	SIN	Prime Lending Rate (EP)

iv. Malaysia (MY)

Variable	Symbol	Proxy
Consumer Price Index (represent Inflation)	MCP	Consumer Prices, Total, Index, 2010 = 100
Producer Price Index	MPI	Production, Industry, Constant Prices, SA, Index, 2015 = 100
Interest rate	MIN	Policy Rates, Bank Negara Malaysia Overnight Policy Rate (OPR)

The methodology used in this study combines standard time series techniques, autoregressive distributed lags model (ARDL) and non-linear ARDL (NARDL). Time series technique (8 steps) involves testing whether there is long term relationship between the variables and it does not assume causality.

In a nutshell, the above twelves (12) variables comprised of 117 months have been filtered by stages within the time series technique. The reduction of variables to eight (8) also occurred at co-integration test was due to the maximum variables can be tested only up to ten (10 variables); thus interest rate has been excluded from each country analysis. The steps of time series technique in comparison with the standard regression analysis can be explained in following manner.

For step no. 1, the unit root tests will be conducted on the level and differenced forms of the variables. This step requires all variables to be non-stationary. However, if a variable is found to be stationary, it signalling that there is no theoretical information in the variable, hence co-integration test cannot be performed. Stationary variables characteristics are defined as variable that have constant mean, variance and covariance.

There are three (3) tests will be conducted including Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and KPSS tests. ADF test (Dickey and Fuller, 1979) takes care and correcting autocorrelation only whilst PP test (Phillips and Perron, 1988) takes care of both autocorrelation and heteroscedasticity. The null hypothesis of both tests is there is non-stationary. On the other hand, KPSS use null hypothesis of there is co-integration between the variables (Kwiatkowski et al., 1992), i.e. the variables are stationary.

Once it is confirmed that variables are non-stationary, Step no. 2 - VAR order selection (VAR) will be performed to determine the optimum number of lag for variables used in the study. From VAR, the result will be used in Johansen co-integration test (Johansen) (Step no. 3) to identify the exact number of co-integrating vectors between the variables and it is based on maximum likelihood (Johansen, 1991). There is no test using Engle-Granger co-integration test since it cannot identify the number of co-integrating vectors, thus Johansen is more advanced in this respect. However, Johansen test is bias towards accepting the null hypothesis of no co-integration. Since p-value of 5% or 10% is used, i.e. error that is acceptable if null hypothesis is rejected is only 5% or 10%, this means 95% or 90% of the time the null hypothesis will be accepted.

Step no. 4 will proceed with ARDL technique, a more advanced technique compared to the standard time series which is introduced by Pesaran et al. (2001) i.e. is a bound testing approach that can be used even for small sample size.

The ARDL test comprised of two main stages. The first stage will be testing of the long run relation between the variables by computing the F-statistic for testing the significance of the lagged levels of the variables in the error correction form of underlying ARDL model. The calculated F-statistic will be compared against the upper and lower critical values as determined by Pesaran et al. (2001).

If the F-statistics fall above the upper boundary, the null hypothesis of no co-integration can be rejected and it can be concluded that the variables move together in the long run. However, if it falls below the lower boundary, the null hypothesis cannot be rejected and there is no co-integration between the variables. In case the F-statistic falls between the two asymptotic critical values, these will result in inconclusive regardless of the stationarity of the variables. Thus, it may have to carry out unit root tests on the variables.

The next step no. 5 namely Vector Error Correction Method (VECM) will continue where error correction term is estimated to determine whether a variable is exogenous or endogenous but it does neither tell the relative strength nor rank the variables.

In brief, when error correction term is found to be significant i.e. p-value less than 5%, the variable actually depends on the error correction term, hence it is an endogenous variable. In contrast, the variable being exogenous or a leader when error correction term is insignificant or p-value more than 5%.

For coefficient of error term, the speed of adjustment to equilibrium can be showed by a greater absolute value which means a faster adjustment and vice versa. Moreover, a positive coefficient means the variable will move away from the equilibrium in the long run while a negative coefficient signalling the variable will return to the equilibrium.

As the long run relationship holds, the next step no. 6 will be non-linear ARDL (NARDL), amore advance technique introduced by Shin et al. (2014). This NARDL is proceed due to the weaknesses found in the preceding ARDL’s steps that assumes linearity and symmetrical adjustment as well symmetrical / constant speed of adjustment from equilibrium i.e. a variable will increase and decrease at the same speed.

The NARDL does not assume linearity or symmetric adjustment. It enables testing linear and non-linear co-integration while differentiating the short run and long run effects of regressors to the dependant variable. If relationship between the focus variables is found to be symmetry, ARDL model is correct and can be used for further discussion. The next section will discuss on the results of each tests performed.

EMPIRICAL RESULTS AND DISCUSSION

Step 1: Unit root test

Table: ADF test

	VARIABLE	Table	ADF	VALUE	T-STAT.	C.V.	RESULT
ADF (LOG FORM)	LUCP	3	ADF(1)=AIC	537.6112	-1.7809	-3.4773	Non-Stationary
		3	ADF(1)=SBC	532.1921	-1.7809	-3.4773	Non-Stationary
	LUIN	3	ADF(5)=AIC	-61.7009	-2.7219	-3.3872	Non-Stationary
		3	ADF(5)=SBC	-70.9172	-2.7219	-3.3872	Non-Stationary
	LUPI	3	ADF(1)=AIC	437.2716	-3.2666	-3.4773	Non-Stationary
		3	ADF(1)=SBC	431.8526	-3.2666	-3.4773	Non-Stationary
	LECP	3	ADF(1)=AIC	329.6091	-2.0822	-3.4773	Non-Stationary
		3	ADF(1)=SBC	324.1901	-2.0822	-3.4773	Non-Stationary
	LEIN	3	ADF(1)=AIC	12.6043	-1.0897	-3.4496	Non-Stationary
		3	ADF(1)=SBC	8.1073	1.0897	-3.4496	Non-Stationary
	LEPI	3	ADF(1)=AIC	358.9254	-2.3152	-3.4773	Non-Stationary
		3	ADF(1)=SBC	353.5064	-2.3152	-3.4773	Non-Stationary
	LSCP	3	ADF(3)=AIC	448.1554	-1.5272	-3.3819	Non-Stationary
		3	ADF(3)=SBC	440.0268	-1.5272	-3.3819	Non-Stationary
	LSIN	3	ADF(1)=AIC	554.7656	-2.5741	-3.4773	Non-Stationary
		3	ADF(1)=SBC	549.3466	-2.5741	-3.4773	Non-Stationary
	LSPI	3	ADF(5)=AIC	129.5871	-3.4192	-3.4432	Non-Stationary
		3	ADF(2)=SBC	121.6586	-3.5819	-3.3404	Stationary
	LMCP	3	ADF(3)=AIC	475.0544	-3.8477	-3.3819	Stationary
		3	ADF(2)=SBC	468.984	-3.8614	-3.4773	Stationary
	LMIN	3	ADF(2)=AIC	267.8911	-2.5777	-3.340	Non-Stationary
		3	ADF(2)=SBC	261.1172	-2.5777	-3.3404	Non-Stationary
	LMPI	3	ADF(2)=AIC	292.2494	-5.3398	-3.4773	Stationary
		3	ADF(1)=SBC	286.8303	-5.3398	-3.4773	Stationary

	VARIABLE	Table	ADF	VALUE	T-STAT.	C.V.	RESULT
ADF (1ST DIFF. FORM)	DUCP	2	ADF(1)=AIC	534.1577	-6.2592	-2.9261	Stationary
		2	ADF(1)=SBC	530.107	-6.2592	-2.9261	Stationary
	DUIN	2	ADF(5)=AIC	-64.5744	-3.995	-2.8072	Stationary
		2	ADF(5)=SBC	-72.591	-3.995	-2.8072	Stationary
	DUPI	2	ADF(5)=AIC	427.888	-3.2776	-2.9257	Stationary
		2	ADF(1)=SBC	423.7875	-6.8517	-2.9261	Stationary
	DECP	2	ADF(5)=AIC	324.3237	-3.4622	-2.9257	Stationary
		2	ADF(1)=SBC	320.2117	-6.8579	-2.9261	Stationary
	DEIN	2	ADF(1)=AIC	11.0797	0.31819	-2.8665	Non-Stationary
		2	ADF(1)=SBC	7.7285	0.31819	-2.8665	Non-Stationary
	DEPI	2	ADF(1)=AIC	353.2677	-8.794	-2.9261	Stationary
		2	ADF(1)=SBC	349.2169	-8.794	-2.9261	Stationary

	DSCP	2	ADF(5)=AIC	448.5457	-2.3647	-2.9257	Non-Stationary
		2	ADF(5)=SBC	439.0941	-2.3647	-2.9257	Non-Stationary
	DSIN	2	ADF(1)=AIC	546.9307	-7.3442	-2.9261	Stationary
		2	ADF(1)=SBC	542.88	-7.3442	-2.9261	Stationary
	DSPI	2	ADF(4)=AIC	127.294	-8.0259	-2.9082	Stationary
		2	ADF(1)=SBC	120.7169	-15.1059	-2.9261	Stationary
	DMCP	2	ADF(3)=AIC	465.7402	-6.0195	-2.9234	Stationary
		2	ADF(1)=SBC	461.5674	-7.9418	-2.9261	Stationary
	DMIN	2	ADF(1)=AIC	262.4257	-5.1962	-2.9261	Stationary
		2	ADF(1)=SBC	258.375	-5.1962	-2.9261	Stationary
	DMPI	2	ADF(4)=AIC	284.6947	-7.6289	-2.9082	Stationary
		2	ADF(1)=SBC	278.7966	-11.7875	-2.9261	Stationary

Table: PP test

	VARIABLE	Table	T-STAT.	C.V.	RESULT
PP (LOG FORM)	LUCP	3	-1.9749	-3.4252	Non-Stationary
	LUIN	3	-2.8593	-3.4307	Non-Stationary
	LUPI	3	-1.5364	-3.4252	Non-Stationary
	LECP	3	-1.0105	-3.4252	Non-Stationary
	LEIN	3	-0.011151	-3.4345	Non-Stationary
	LEPI	3	-2.3026	-3.4252	Non-Stationary
	LSCP	3	-0.81919	-3.4252	Non-Stationary
	LSIN	3	-2.2106	-3.4252	Non-Stationary
	LSPI	3	-7.3935	-3.4252	Stationary
	LMCP	3	-2.5052	-3.4252	Non-Stationary
	LMIN	3	-1.9917	-3.4252	Non-Stationary
	LMPI	3	-8.1927	-3.4252	Stationary

	VARIABLE	Table	T-STAT.	C.V.	RESULT
PP (1ST DIFF. FORM)	DUCP	2	-7.8164	-2.9153	Non-Stationary
	DUIN	2	-13.5048	-2.8798	Non-Stationary
	DUPI	2	-9.0041	-2.9153	Non-Stationary
	DECP	2	-8.146	-2.9153	Non-Stationary
	DEIN	2	0.14292	-2.8682	Stationary
	DEPI	2	-13.6828	-2.9153	Non-Stationary
	DSCP	2	-13.3466	-2.9153	Non-Stationary
	DSIN	2	-11.2341	-2.9153	Non-Stationary
	DSPI	2	-24.7439	-2.9153	Non-Stationary
	DMCP	2	-8.6172	-2.9153	Non-Stationary
	DMIN	2	-13.3288	-2.9153	Non-Stationary
	DMPI	2	-35.3395	-2.9153	Non-Stationary

Table: KPSS test

	VARIABLE	Table	T-STAT.	C.V.	RESULT
KPSS (LOG FORM)	LUCP	2	0.12173	0.14467	Non-Stationary
	LUIN	2	0.098451	0.14395	Non-Stationary
	LUPI	2	0.1494	0.14467	Stationary
	LECP	2	0.12718	0.14467	Non-Stationary
	LEIN	2	0.12714	0.14395	Non-Stationary
	LEPI	2	0.081292	0.14467	Non-Stationary
	LSCP	2	0.16202	0.14467	Stationary
	LSIN	2	0.13571	0.14467	Non-Stationary
	LSPI	2	0.11307	0.14467	Non-Stationary
	LMCP	2	0.12379	0.14467	Non-Stationary
	LMIN	2	0.14831	0.14467	Stationary
	LMPI	2	0.076012	0.14467	Non-Stationary

	VARIABLE	Table	T-STAT.	C.V.	RESULT
KPSS (1ST DIFF. FORM)	DUCP	1	0.15866	0.39069	Stationary
	DUIN	1	0.23292	0.4041	Stationary
	DUPI	1	0.11799	0.39069	Stationary
	DECP	1	0.28853	0.39069	Stationary
	DEIN	1	0.26669	0.4041	Stationary
	DEPI	1	0.081416	0.39069	Stationary
	DSCP	1	0.2861	0.39069	Stationary
	DSIN	1	0.10614	0.39069	Stationary
	DSPI	1	0.25094	0.39069	Stationary
	DMCP	1	0.11595	0.39069	Stationary
	DMIN	1	0.090705	0.39069	Stationary
	DMPI	1	0.18347	0.39069	Stationary

Based on ADF, PP and KPS tests, the results are mixed at log and 1st difference form. Therefore, this study cannot proceed with Engle-Granger or Johansen co-integration tests as they require all variables to be non-stationary. The ARDL will be used in the later section, since it does not require all variables to be non-stationary, to identify whether there is long run relationship between the variables. Nevertheless, this study will use the ADF and PP tests at this juncture to enable carrying out Engle-Granger and Johansen tests. In addition, since the co-integration test allowed up to the maximum of ten (10) variables, the next stage will exclude interest rate variable from each country, thus there will be eight (8) variables to be used in the following stages.

Step 2: VAR order selection

```
 Test Statistics and Choice Criteria for Selecting the Order of the VAR Model
******************************************************************************
 Based on  73 observations from 2009M4 to 2015M4. Order of VAR = 2
 List of variables included in the unrestricted VAR:
 DUCP            DUIN            DUPI            DECP            DEIN
 DEPI            DSGCP           DSGIN           DSGPI           DMYCP
 DMYIN           DMYPI
 List of deterministic and/or exogenous variables:
 INPT
******************************************************************************
 Order     LL        AIC       SBC            LR test          Adjusted LR test
 2      2803.4    2503.4    2159.8             ------               ------
 1      2657.1    2501.1    2322.4  CHSQ(144)= 292.6096[.000]  192.4009[.004]
 0      2515.8    2503.8    2490.0  CHSQ(288)= 575.1833[.000]  378.2027[.000]
******************************************************************************
 AIC=Akaike Information Criterion     SBC=Schwarz Bayesian Criterion
```

Prior to the next stage, no. of lags or order for vector autoregression (VAR) should be determined. This VAR order selection has criteria namely based on Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC). AIC is less concerned on over parameter and tend to choose higher order of VAR, whilst SBC is more concerned on over parameter, thus to choose lower order of VAR. Given the above table shows that the no. of lags or order of VAR is two (2).

Step 3: Johansen Co-integration test

Lag order 2, Unrestricted intercept and trend

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
  Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
******************************************************************************
74 observations from 2009M3 to 2015M4. Order of VAR = 2.
List of variables included in the cointegrating vector:
LUCP                I
LEPI                LSGCP               LSGIN               LSGPI               LMYCP
LMYIN               LMYPI               Trend
List of eigenvalues in descending order:
.77502      .71073      .64930      .48143      .43535      .36210      .35180
.28083      .21248      .17316      .15261      .098361
******************************************************************************
```

Null	Alternative	Statistic	95% Critical Value	90% Critical Value	Result
r = 0	r = 1	110.3876	78.42	75.02	No cointegration
r<= 1	r = 2	91.7888	72.5	69.45	1 cointegration
r<= 2	r = 3	77.538	67.05	63.6	2 cointegration
r<= 3	r = 4	48.5948	61.27	58.09	
r<= 4	r = 5	42.2948	55.14	52.08	
r<= 5	r = 6	33.2689	49.32	46.54	
r<= 6	r = 7	32.0834	43.61	40.76	
r<= 7	r = 8	24.3944	37.86	35.04	
r<= 8	r = 9	17.6764	31.79	29.13	
r<= 9	r =10	14.0707	25.42	23.1	
r<=10	r =11	12.2539	19.22	17.18	
r<=11	r =12	7.662	12.39	10.55	

```
******************************************************************************
Use the above table to determine r (the number of cointegrating vectors).
```

```
Cointegration with unrestricted intercepts and restricted trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
******************************************************************************
74 observations from 2009M3 to 2015M4. Order of VAR = 2.
List of variables included in the cointegrating vector:
LUCP                LUIN                LUPI                LECP                LEIN
LEPI                LSGCP               LSGIN               LSGPI               LMYCP
LMYIN               LMYPI               Trend
List of eigenvalues in descending order:
.77502      .71073      .64930      .48143      .43535      .36210      .35180
.28083      .21248      .17316      .15261      .098361
******************************************************************************
```

Null	Alternative	Statistic	95% Critical Value	90% Critical Value	Result
r = 0	r>= 1	512.0138	364.84	355.9	No cointegration
r<= 1	r>= 2	401.6262	314.11	305.75	1 cointegration
r<= 2	r>= 3	309.8374	265.77	258.01	2 cointegration
r<= 3	r>= 4	232.2994	222.62	215.87	3 cointegration
r<= 4	r>= 5	183.7046	182.99	176.92	4 cointegration
r<= 5	r>= 6	141.4098	147.27	141.82	
r<= 6	r>= 7	108.1408	115.85	110.6	
r<= 7	r>= 8	76.0574	87.17	82.88	
r<= 8	r>= 9	51.663	63	59.16	
r<= 9	r>=10	33.9867	42.34	39.34	
r<=10	r>=11	19.916	25.77	23.08	
r<=11	r =12	7.662	12.39	10.55	

```
******************************************************************************
Use the above table to determine r (the number of cointegrating vectors).
```

Based on the above Johansen test - maximal eigenvalue and trace; both table have co-integration at Lag order 2, Unrestricted intercept and trend, but with different no. of co-integration. Therefore, all variables may have long term relationship in this respect. Next, this study will proceed with co-integration test using ARDL (step no. 4).

Step 4: Co-integration tests: ARDL

	4 COUNTRY - CPI & PI		Variables		Lower bound	Upper bound
	LUCP LUPI LECP LEPI LSGCP LSGPI LMYCP LMYPI		8	95%	2.604	3.746
	DUCP DUPI DECP DEPI DSGCP DSGPI DMYCP DMYPI		8	90%	2.29	3.383
	Dependant	Variables for regression	F-statistic	95%	90%	
1	DUCP	LUCP I LUPI, LECP, LEPI, LSGCP, LSGPI, LMYCP, LMYPI	1.5415	Fail to reject H0	Fail to reject H0	F(8,71)= 1.5415[.159]
2	DUPI	LUPI I LUCP , LECP, LEPI, LSGCP, LSGPI, LMYCP, LMYPI	3.8951	Reject the null	Reject the null	F(8,71)= 3.8951[.001]
3	DECP	LECP I LUPI, LUCP, LEPI, LSGCP, LSGPI, LMYCP, LMYPI	2.1972	Fail to reject H0	Fail to reject H0	F(8,71)= 2.1972[.038]
4	DEPI	LUPI I LUCP , LECP, LEPI, LSGCP, LSGPI, LMYCP, LMYPI	4.6238	Reject the null	Reject the null	F(8,71)= 4.6238[.000]
5	DSGCP	LUPI I LUCP , LECP, LEPI, LSGCP, LSGPI, LMYCP, LMYPI	4.5727	Reject the null	Reject the null	F(8,71)= 4.5727[.000]
6	DSGPI	LUPI I LUCP , LECP, LEPI, LSGCP, LSGPI, LMYCP, LMYPI	2.4047	Fail to reject H0	Inconclusive	F(8,71)= 2.4047[.023]
7	DMYCP	LUPI I LUCP , LECP, LEPI, LSGCP, LSGPI, LMYCP, LMYPI	1.3653	Fail to reject H0	Fail to reject H0	F(8,71)= 1.3653[.227]
8	DMYPI	LUPI I LUCP , LECP, LEPI, LSGCP, LSGPI, LMYCP, LMYPI	2.4478	Fail to reject H0	Inconclusive	F(8,71)= 2.4478[.021]

Based on the above bound test with null hypothesis of no co-integration (no long run relationship), the test result shows that F-statistics for the United States Producer Price Index (USPI), European Producer Price Index (EUPI) and Singapore Consumer Price Index (SCPI) recorded at 3.8951, 4.6238 and 4.5727 respectively is higher than the upper bound critical value of 3.746 (95% interval) and 3.383 (90% interval). Therefore, the null hypothesis can be rejected and it can be concluded that there is a long run relationship for USPI, EUPI and SCPI; and the relationship is not spurious. However, when the remaining variables as above are the dependant variables, the results show there is no co-integration. Moreover, there are two variables namely Singapore Producer Price Index (SGPI) and Malaysia Producer Price Index (MYPI) within the upper and lower bound critical value that remarks as inconclusive position.

Since the above has at least one has co-integration i.e. the advantage of ARDL, there is theoretical link between the variable, thus this paper will then proceed to VECM to identify the causality and Non-linear ARDL (NARDL) to conclude the linear and non-linear co-integration while differentiating the short and long run effects.

Step 5: Vector Error Correction Model (VECM)

i. VECM - Akaike Information Criterion (VAIC)

ecm1(-1)	Coefficient	Standard Error	T-Ratio [Prob.]	C.V.	Result	Remarks
dLUCP	-0.0041723	0.038957	-.10710[.915]	5%	Exogenous	Fail to reject the null
dLUPI	-0.18192	0.040732	-4.4664[.000]	5%	Endogenous	Reject the null
dLECP	-0.12226	0.044695	-2.7354[.007]	5%	Endogenous	Reject the null
dLEPI	-0.18982	0.055944	-3.3931[.001]	5%	Endogenous	Reject the null
dLSGCP	-0.081304	0.039107	-2.0790[.040]	5%	Endogenous	Reject the null
dLSGPI	-0.92419	0.16825	-5.4929[.000]	5%	Endogenous	Reject the null
dLMYCP	-0.14261	0.050594	-2.8188[.006]	5%	Endogenous	Reject the null
dLMYPI	-0.71616	0.089662	-7.9874[.000]	5%	Endogenous	Reject the null

ii. VECM - Schwarz Bayesian Criterion (VSBC)

ecm1(-1)	Coefficient	Standard Error	T-Ratio [Prob.]	C.V.	Result	Remarks
dLUCP	-0.046796	0.038271	-1.2228[.224]	5%	Exogenous	Fail to reject the null
dLUPI	-0.14877	0.038496	-3.8645[.000]	5%	Endogenous	Reject the null
dLECP	-0.11969	0.045494	-2.6309[.010]	5%	Endogenous	Reject the null
dLEPI	-0.18009	0.047359	-3.8026[.000]	5%	Endogenous	Reject the null
dLSGCP	-0.070369	0.040177	-1.7515[.083]	5%	Exogenous	Fail to reject the null
dLSGPI						No lagged dependent variable in the model
dLMYCP	-0.1986	0.036438	-5.4504[.000]	5%	Endogenous	Reject the null
dLMYPI	-0.71004	0.090692	-7.8291[.000]	5%	Endogenous	Reject the null

In VECM test, there are two sets of criteria being tested namely under Akaike Information Criterion (VAIC) and Schwarz Bayesian Criterion (VSBC). Both criteria results are based on a p-value of less than 5% means that the null hypothesis of exogenous variable is rejected, hence the variable is endogenous.

Based on the VAIC table, the United States Consumer Price Index (UCP) is the only exogenous while under VSBC, the UCP and Singapore Consumer Price (SCP) are exogenous; or in short they are controlled by external factors. Both are considered intuitively relevant in general term as both are dominant features in economy markets i.e. world market for both variables and for SCP which influence by the Asian market too.

Step 6: Non-linear ARDL

Based on VECM results, it is noted that two (2) countries are exogenous with regards to Consumer Price Index (CPI) namely the United States and Singapore, and followed by endogenous countries namely European Union and Malaysia. Hence, for the purpose of NARDL, focus will be only the United States Consumer Price Index (CPI) and its Producer Price Index (PI) as exogenous and endogenous respectively. This is to determine whether CPI could control PI and to know whether the long run relationship exist between these two variables (UCP and UPI), and whether the relationship is linear or non-linear.

- **<u>The United States - CPI (UCP) and PI (UPI)</u>**

<u>Co-integration test statistics</u>

Asymmetry statistics:

Exog. var.	Long-run effect [+] coef.	F-stat	P>F	Long-run effect [-] coef.	F-stat	P>F
LUCP	1.979	77.87	0.000	-5.926	29.07	0.000

	Long-run asymmetry F-stat	P>F	Short-run asymmetry F-stat	P>F
LUCP	19.75	0.000	2.753	0.100

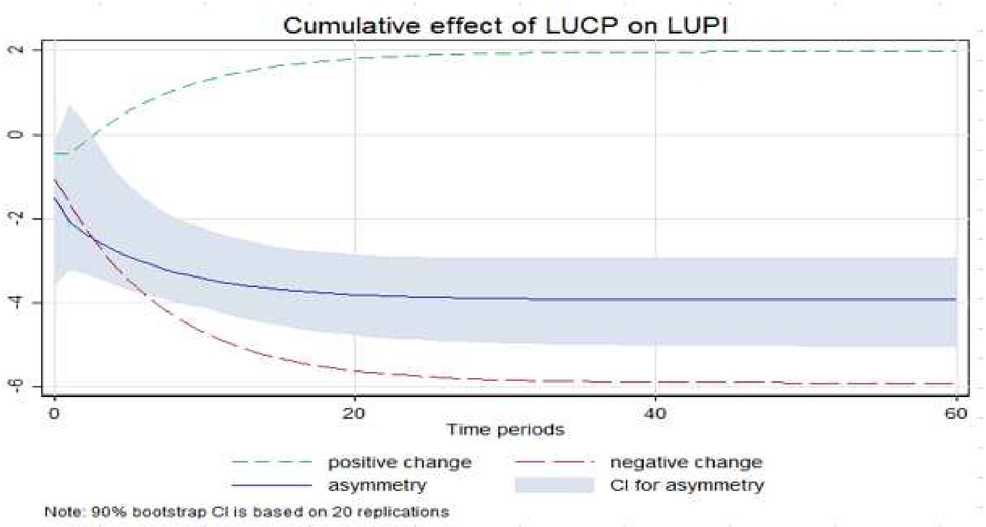
Note: Long-run effect [-] refers to a permanent change in exog. var. by -1

Cointegration test statistics: t_BDM = -4.2314
F_PSS = 7.4626

Model diagnostics	stat.	p-value
Portmanteau test up to lag 40 (chi2)	29.04	0.9003
Breusch/Pagan heteroskedasticity test (chi2)	.05108	0.8212
Ramsey RESET test (F)	1.14	0.3365
Jarque-Bera test on normality (chi2)	4.111	0.1280

Bootstrapping (one dot per 10 replications): ..

The above table shows significant results i.e. F-stat 7.46 is more than upper bound between 5.109 to 5.872 at 90% level (as per Table B.1 – Case III: Intercept and trend). There is significant long run asymmetry, also significant short run asymmetry on 90% level. In the long run, if increase the independent variable i.e. UCP by 1%, the dependant i.e. UPI increase by 1.979%. And when UCP decreases by 1%, the dependant variable decrease by 5.9 percent. For model diagnostic, due to p-value is more than 5%, there is no autocorrelation, heteroscedasticity and misspecification on non-normality in the model.



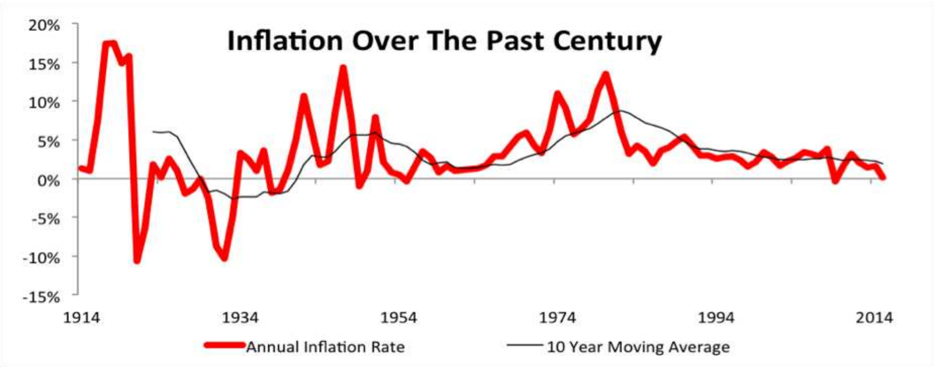
Based on the plot bootstrap above, the cumulative effect on LUCP on LUPI is negatively asymmetrical. It reacts to negative shocks more than positive shocks. Therefore, when the price of goods and services is increase, the producer price index will increase in smaller proportion compared to when the price of good and services are reduced.

The above asymmetrical movement could relate to asymmetric price transmission (APT) which can be attributable to many factors. Market power is one of the major explanations of APT (Deltas, 2008; Peltzman, 2000). As the CPI leads to PI it might be explained by the market power in input markets when the sellers of PI input resources respond more rapidly to shocks to CPI inflation that increase derived demand for inputs than those diminish it. Moreover, wage rigidity and price inflexibility in retail and input markets may lead to APT (Caporale et al., 2002).

The US government has faced the momentous task of reversing the effects of the recession with a combination of expansionary fiscal and monetary policy. On the fiscal side, government stimulus spending and tax cuts prevented further deterioration of the economy. On the monetary side, the Federal Reserve has tackled economic weakness with both traditional and unconventional policies. This includes not only holding interest rates at the lower bound, but also the unconventional practice of the government buying large amounts of financial assets to increase the money supply and hold down long term interest rates—a practice known as “quantitative easing”. While the labor market has recovered significantly and employment has returned to pre-crisis levels, there is still widespread debate regarding the health of the US economy.

Despite its best efforts, the Federal Reserve has been unable to push the economy to its targeted 2% annual inflation rate. For four years, now inflation has stayed resolutely below that target even as the Fed deployed an unprecedented program of bond buying and low interest rates in an effort to push prices up.

While the analysts predicted that the Fed's actions would lead to significant inflation probably overstated the power the central bank has on the economy, the most significant cause of low inflation may nothing to do with monetary policy.



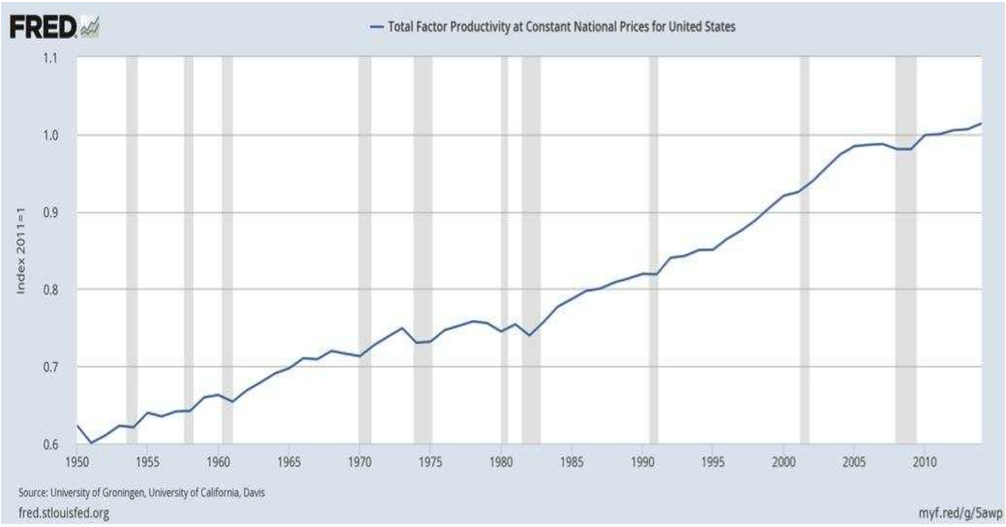
Sources: Bureau of Labor Statistics

The above graph shows that since the early 80's, the end of the "Great Inflation," increases in the Consumer Price Index (CPI) have been steadily getting smaller and smaller. Compared to the wild swings of the rest of the 20th century, this trend represents a dramatic change.

This new trend coincides with a couple of major technological innovations that have had a long-term impact on prices namely through development of the first Distributed Control System (DCS) in the US (1970's), a tool that drastically increased the capability of factories to automate parts of the manufacturing process by Honeywell. Secondly, in 1994 Netscape was the first web browser that made the internet accessible to the broader public and presaged the internet takeover of so many facets of the economy.

These technologies and the subsequent innovations they inspired have combined to hold down inflation by putting pressure on wages, increasing productivity, and encouraging competition.

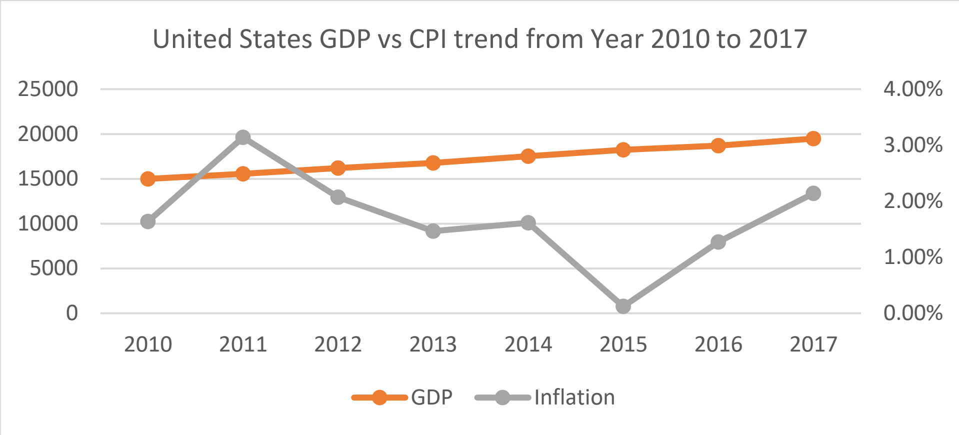
Figure 1: Increasing U.S. Total Factor Productivity



Sources: St. Louis Fed

As the US economy features a highly-developed and technologically-advanced services sector, which accounts for about 80% of its output, it is now time that Fed to consider technology's roles to control the inflation besides traditional monetary policy. This is due to the US economy is dominated by services-oriented companies in areas such as technology, financial services, healthcare and retail. Figure 1 shows the increasing trend in US Total Factor Productivity due to change in technology.[5]

[5] **https://www.forbes.com/sites/greatspeculations/2016/09/28/how-the-internet-economy-killed-inflation/#56db44f9788b**



From the perspectives of GDP which is also related to aggregate demand and supply, the above trend is at the increasing mode compared to series of fluctuation on inflation rates. Thus, signalling a valid reason to concur that technology could be the additional tool to control the inflation besides traditional monetary policy due to overwhelming technologies disruption.

CONCLUDING REMARKS AND POLICY IMPLICATIONS

The policymakers are facing the dilemma in managing the economy at all time. The effectiveness of economic structure either fiscal or monetary policy could sometime digress or not meeting the desired "dual mandate" for price stability and maximum employment as happened in the United States. Moreover, theoretical and practical ways in managing the economy should address options and mixed approaches in achieving the best economy. Accordingly, as it is noted that the US Consumer Price Index (UCP) is the most exogenous variable and its Producer Price Index (UPI) as endogenous has resulted in negative shocks more than positive shocks, which the market power in input market needs to "handle with care".

Therefore, in order to control inflation, the policymakers should also introduce more competition into the retail and input markets. Many empirical studies have suggested that market power can lead to asymmetric price transmission (APT) but there are still other factors leading to APT, which include adjustment or menu costs (Levy et al.,1997; Dutta et al., 1999), inventory management (Blinder, 1982) as well as costs of stockouts and search costs (Loy et al., 2016). The link between market power and APT is therefore theoretically ambiguous (Meyer and Cramon-Taubadel, 2004). Future research needs to be taken on the causes of APT on specific markets related to areas of production namely industry-based, commodity-based and commodity-based final demand-intermediate demand.

Besides, it is also evidenced by the market that technology could hold down inflation and stimulates the GDP thru PI by putting pressure on wages, increasing productivity, and encouraging competition. Therefore, mixed approaches should be executed by the policymakers in managing the inflation and PI to achieve the very best level of a country's economy.

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