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Co-Movement of Output and Price in Malaysia: Empirical Evidence and Macroeconomic Policy Implications

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Abstract

This study conducts a comprehensive analysis on the output-price relationship in Malaysia with the objective of identifying the major source of macroeconomic fluctuations in Malaysia, thus drawing relevant policy recommendations for effective macroeconomic stabilization policy. We analyze the short- and long-run co-movements between real activity and prices using several tests in efforts to arrive at conclusive findings. Apart from the descriptive analysis, the study relies on the VAR forecast errors based on Den Haan and Sumner (2000). The study considers an extended data sample of monthly frequency covering the period from January 1971 to November 2009. The study aims to contribute towards enriching policy recommendations for effective macroeconomic stabilization policy in the country.

Keywords: *Business cycles, Correlation, VAR, Stabilization policy, Malaysia*

1. INTRODUCTION

Macroeconomic stabilization policy requires a rigorous and updated assessment of the structural relationship of major macroeconomic variables so as to remain effective and relevant. The basic relationships of major macroeconomic variables provide important information regarding the best policy responses to be designed in the specific context of an economy. In this regard, output-price relationship has captured the interest of macroeconomists and policymakers alike for the crucial information that it conveys.

The nature of output-price relationship provides the information about the dominant force that drives the economic cycles. An economy that is characterized by a positive relation between output and price suggests the dominance of the demand shocks in influencing the macroeconomic fluctuations. In the context of an expansionary fiscal policy, fiscal stimulus exerts a significant impact on the aggregate demand side of the economy resulting in positive price surprises, thus the increase in output is associated with price increases in the short run – a phenomenon called "demand-pull" inflation. As proposed by the traditional business cycle model, the identification of the demand shocks as the predominant cause of macroeconomic fluctuations entails that stabilization policies based on the Keynesian framework are effective policy interventions to revive the economy. A discretionary policy intervention is recommended as the economic fluctuations are just temporary deviations around a stable, full employment level of output (Phelps, 1967; Friedman, 1968). Thus, a normal policy prescription for a demand-shock predominant economy during an economic slowdown would be fiscal pump-priming to revive the aggregate demand.

In contrast, in an economy where supply-shock is dominant, output varies negatively with anticipated price changes. In this case, the production side of the economy is relatively more sensitive to macroeconomic changes than the consumption side, thus influencing the economic cycles. For instance, in anticipation of an increase in energy prices, firms cut down on production due to the anticipated increase in the cost of inputs. This causes a decline in

output and raising output prices – a phenomenon called "cost-push" inflation. As advocated by the monetarists, policy rules are more effective policy response when supply-side shocks exert major influence on the macroeconomic fluctuations. This policy framework works better than the discretionary framework since the main source of macroeconomic fluctuation comes from the optimal response of economic agents to unforeseen supply side shocks. Therefore, to reduce the uncertainties, adherence to simple monetary policy rule is proposed.

In essence, clear understanding of the output-price relationship enables the policymakers to identify the major source of macroeconomic fluctuations, which is the key to effective policy prescriptions to stabilize the economy. In view of this, identifying the relationship between output and price in an economy has been a subject of research interest. A rich literature on this topic is available in the case of the developed countries, particularly the US and advanced countries' economic groupings, yet not much has been done for the case of the developing countries. To the best of our knowledge, there have been no studies undertaking a rigorous empirical exploration of the output-price relationship in the case of Malaysia. Motivated by the objective to fill the gap in the literature and assess the current macroeconomic strategy, this study aims to determine the cyclical behavior between output and price in Malaysia so as to identify the major source of macroeconomic fluctuations in the economy. By employing an extended sample of monthly data from January 1971 to November 2009 and several methods of empirical investigation, the study aims to arrive at conclusive findings of the nature of output-price relationship in the Malaysian economy. More specifically, this paper adopts the methodology suggested by Den Haan and Sumner (2000) to study the co-movement of output and prices for Malaysia with the aim of comparing the output-price relationship in Malaysia and that of the US and other G7 countries. Ultimately, the study hopes to contribute towards drawing relevant policy framework for effective implementation of macroeconomic stabilization policy in the country.

The study is organized as follows. Section 2 reviews the existing literature on the output-price nexus in various economic settings and using different methods of analysis. Section 3 discusses the data and methodology adopted in this study. Section 4 presents the results and lastly, section 5 summarizes major findings and discusses major policy recommendations.

2. LITERATURE REVIEW

Reflecting its importance in providing the input for effective macroeconomic stabilization policy amid the dynamic nature of the economy, the topic of output-price nexus has captures substantial research interests, particularly in the developed economies. In general, existing empirical studies have shown that the nature of output-price relationship varies across countries and different time periods.

In the case of the US, Kydland and Prescott (1990) document the anti-cyclical behavior of output and prices over the period 1954-1989. In line with the substantial evidence on the negative relationship between output and price, Kydland and Prescott (1990) confirmed that the relationship between output and price in the post-Korean war period is counter-cyclical, suggesting that the supply-side of the economy has been dominant in influencing the business cycles in the US. Indeed, studies focusing on the US case have consistently shown that output and price are negatively correlated (see, for example, Cooley and Ohanian, 1991; Backus and Kehoe, 1992; Smith, 1992). The findings of the cyclical behavior of price and output are robust and conclusive in view of extended sample sizes in terms of time period and cross-country evidence. More recent studies such as that of Cover and Hueng (2001) on the US covering an extended sample period from 1876 to 1999 also arrives at similar findings. Using the bi-variate GARCH error process based on the VAR methodology, the study documents time-varying property of the cyclical behavior of output and price, with

output-price correlation is found to be positive before the 1945 period, and turned negative in the post-1964 period. In addition, it is also found that the estimated correlation is typically positive during economic recession and negative during economic expansion. Other supporting studies include that of Wolf (1991), Cooley and Ohanian (1991), Smith (1992), and Chada and Prasad (1993).

Recent studies in this area apply more innovative and robust econometric techniques to arrive at more conclusive findings. Lee (2006) uses Engle's (2002) dynamic conditional correlation-GARCH model, which represent a significant methodological departure from the existing literature. Based on a sample period 1900-2002, the study confirms the time varying property of the output-price relationship in the US such that they tend to be pro-cyclical in the pre-war period and anti-cyclical in the post-war period. Several other studies focus on the output-price relationship with the aim of analyzing the viability of macroeconomic harmonization for regional economic groupings. In this context, clear understanding of the relationship between real activity and prices in the member countries is even more crucial, particularly in considering for the possibility of macro-economic policy harmonization. For example, Den Haan and Sumner (2001) study the output-price relationship in the context of the G7 countries, namely Canada, France, Germany, Italy, Japan, United Kingdom and the US using Vector Auto-Regressive (VAR) forecast errors and frequency domain filters. Using industrial production to represent output and Consumer Price Index to represent price, the study documents several interesting findings on the relationship between output and price across all the countries. In particular, the output-price relationship is found to be significantly negative in the long run and significantly higher in the short run. In addition, studies on the developed countries which show similar results include Fiorito and Kollintzas (1994) for the G7 countries and Backus and Kehoe (1992) for ten OECD countries. These studies support that prices were pro-cyclical in the pre-war period but turned counter-cyclical in the post-war period.

Compared to the developed countries, studies on output-price nexus in the case of developing countries have been limited. In the context of the ASEAN economies, the study by Kassim and Abd. Majid (2008) adopts robust time series analysis of ARDL approach to test the nature of the output-price relationship for major ASEAN economies, namely Malaysia, Indonesia, Thailand, Singapore and the Philippines over two sample periods: the pre-crisis period (1990 to 1996) and the post-crisis period (2000 to 2006). The study documents that the output-price relationship has changed in several countries following the Asian financial crisis in 1997/1998. While there is a clear business cycle synchronization among the ASEAN-5 countries in the short-run, results have been mixed in the long run. The results suggest that for many of the ASEAN economies, the output-price relationship within the countries have changed following the crisis in 1997/1998, thus macroeconomic harmonization efforts need to be stepped up in order to achieve business cycles synchronization in the ASEAN-5 countries. The results also show that the nature of output-price relationship across the major ASEAN economies are not standardized, that is demand shocks are predominant in Indonesia, Malaysia and the Philippines, while supply-shocks are predominant in Singapore and Thailand. Thus, macroeconomic policies which stimulate the demand side of the economy are deemed as more suitable in the cases of Indonesia, Malaysia and the Philippines, while policies that favor the supply or production-side are more effective for Singapore and Thailand. The dichotomy in the output-price relationships in these economies implies that different prescriptions are needed in the macroeconomic management in these countries. As such, the ASEAN countries have yet to achieve the level of macroeconomic integration that would allow similar macroeconomic prescription to be implemented for the economic grouping. This result also suggests that macroeconomic policy harmonization could be cumbersome in view of the different sources of macroeconomic fluctuations in these countries.

Empirical studies on output-price relationship in the context of individual developing country have been scarce. In many cases, findings of these studies are inconsistent. Kim (1996) investigates the output-price relationship in two Asian economies, namely Korea and Taiwan and finds that price is negatively correlated with output, while inflation is positively correlated with output. For Korea, Yoo (1992) finds negative relationship between output and price, while Jun (1992) supports the pro-cyclical behavior between the two. Studies on the output-price nexus focusing on the Malaysian case, to the best of our knowledge, have been non-existence. In this regard, the study hopes to contribute towards enriching the literature in this area by focusing on the specific case of Malaysia and providing more recent evidence on the output-price relationship in the context of the Malaysian economy.

3. DATA AND METHODOLOGY

3.1 Data

In efforts to investigate the relationship between output and price in the Malaysian economy, we use the Industrial Production Index (IPI) to represent real economic activity and the Consumer Price Index (CPI) to represent price. The selection of the IPI to represent output instead of the Gross Domestic Product is due to two reasons. First, the IPI is available on monthly basis, thus enabling higher data frequency that can help to capture more detailed time series trend of the analysis. Also, the monthly frequency of IPI matches that of the CPI, which is also available on monthly basis. Thus, the study focuses on the period from January 1971 to November 2009. For comparison purposes, the study also analyzes quarterly data on output and price for the period from first quarter of 1970 to third quarter of 2009. The sample period of the study is strictly constrained by the data availability. Both variables are in real terms with based year at 2005 and expressed in logarithmic form. All data are gathered from the *International Financial Statistics* database 2010 published by the International Monetary Fund.

3.2 Methodology

In this section we describe the methodology suggested by Den Haan (2000) for measuring correlations at different forecast horizons. There are two restrictions in using the unconditional correlation coefficient to investigate the dynamic short-run relationship. First, it is effective only for stationary variables, and second, it does not account for important information about the dynamic characteristics in the co-movement of variables. To solve the above restrictions on the orders of integration and lost information, we adopt the correlations of VAR forecast errors at different horizons introduced by Den Haan and Sumner (2000) to examine the co-movement of output and price. The method makes use of forecast errors for assessing co-movement and is attractive for several reasons. First, the method does not require the applications of any modelling assumptions, such as VAR ordering or structural assumptions on the error terms. Second, it does not require that the data be de-trended or that the variables in the model have to be of identical orders of integration.

Based on the above, consider the following VAR in levels with polynomial time trend

$$X_t = \mu + \beta t + \delta t^2 + \sum_{j=1}^{L} D\varphi_j \, Y_{t-p} + \varepsilon_t \tag{1}$$

Where X_t is 2×1 vector that containing the log price level p_t and the log of output y_t, μ, β and δ are 2×1 vectors of coefficients; φ_j is an 2×2 matrix of auto-regressive coefficients at lag j and the total number of lags included is equal to L. ϵ_t is an 2×1 vector of residuals that are assumed to be serially uncorrelated but can be correlated with each other.

Denote the *k*-period ahead forecast and *k*-period forecast error of the variables for output y by $E_t(y_{t+k})$ and $y_{t,t+k}^{ue}$, respectively. Let the unexpected forecast error in the output forecasted k-periods ahead at time t is $y_{t,t+k}^{ue} = y_{t+k} - E_t(y_{t+k})$. In a similar fashion, we have $p_{t,t+k}^{ue} = py_{t+k} - E_t(py_{t+k})$. Then, the covariance coefficient and correlation coefficient between $y_{t,t+k}^{ue}$ and $p_{t,t+k}^{ue}$ are denoted by $COV(k)$ and $COR(k)$, respectively.

Den Haan and Sumner (2000) point out that if all variables included in X_t are stationary, then $COR(k)$ will converge to the unconditional correlation coefficient between output y_t and price $p_t$as k goes to infinity. If some variables in X_t are non-stationary, then their statistics might not converge, but can be estimated consistently for a fixed k. However, this approach may not be concerned with the order of integrated variables included in X_t, but only with the situation in which the number of lags must be large enough to guarantee that ε_t is serially uncorrelated and not integrated.

4. RESULTS AND DISCUSSION

4.1 Co-movements with correlation coefficients

The co-movement of output and price is being analyzed by estimating the magnitude of cross correlations coefficient between the filtered output and price at different lags and leads. In this case, a positive contemporaneous correlation coefficient at a significant magnitude indicates price is pro-cyclical, while a negative correlation coefficient reflects that output and price are counter-cyclical. While the correlation coefficient of a value close to zero indicates price is contemporaneously uncorrelated with output. With respect to the non-contemporaneous correlation coefficients, price is said to be leading (lagging) the cycle of output by *k* period(s) if the absolute value of the coefficient is maximum for a positive (negative) value of *k*, and is synchronous with output if the coefficient is maximum at $k = 0$. To avoid the quantitative sensitivity of computed movements with respect of *t* filter used, three different filtering methods, namely first-difference, HP-filtering and Band-Pass filtering are used. The results are shown in Tables 1 and 2.

As shown in Table 1, the cross-correlation analysis is applied on three subsets of data: 1970Q1-2009Q3, 1980Q1-2009Q3, and 1990Q1-2009Q3. The categorization would allow the determination if there is any changes in the output-price relationship in the more recent periods. The table reports the cross-correlation between output and price at different leads and lag for quarterly data. In panel A, we analyze the correlation coefficients between output growth (change in IPI) and inflation rates (change in CPI). The results show consistent evidence that the relationships between output growth-inflation rate have been negative throughout the three sample periods. In particular, the cross-correlation has been significant negative (-0.21) with lag in the period 1970Q1-2009Q3, significant negative (-0.10) with lag in the period 1980Q1-2009Q3, and significant negative (-0.17) with lag in the period 1990Q1-2009Q3.

The cross-correlation analysis is also applied on output and price using the HP and BK filters. Consistent findings can be observed on the results of the cross-correlation using the HP and BK filters. As shown in panel B, the results based on the HP filter showed significant negative with lag in all the three sample periods. Similarly, the results based on the BK filter (panel C) also show significant negative with lag for all the three sample periods.

Table 1: Cross-correlation with filters (quarterly data)

	-3	-2	-1	0	1	2	3
Panel A:	Correlation of output growth and inflation $COR(\Delta y_t, \Delta p_{t+k})$						
1970Q1-2009Q3	-0.09*	-0.12*	-0.03	0.06	-0.01	0.10	0.01
1980Q1-2009Q3	-0.10	-0.10*	-0.01	0.03	-0.05	0.05	-0.02
1990Q1-2009Q3	-0.17*	-0.13*	-0.02	0.03	-0.03	0.08	-0.01
Panel B:	Correlation of HP-filtered output and price $COR(y_t^{hp} p_{t+k}^{hp})$						
1970Q1-2009Q3	-0.22*	-0.19*	-0.13	-0.05	-0.02	0.02	0.02
1980Q1-2009Q3	-0.21*	-0.16*	-0.10	-0.04	-0.02	0.01	0.02
1990Q1-2009Q3	-0.22*	-0.13	-0.02	0.08	0.13	0.17	0.16
Panel C:	Correlation of BK-filtered output and price $COR(y_t^{bk} p_{t+k}^{bk})$						
1970Q1-2009Q3	-0.21*	-0.18*	-0.13	-0.10	-0.08	-0.05	-0.02
1980Q1-2009Q3	-0.23*	-0.17*	-0.09	-0.05	-0.03	0.01	0.01
1990Q1-2009Q3	-0.39*	-0.28*	-0.11	-0.05	-0.01	0.03	0.05

Notes: * indicates a coefficient is significantly different from zero using a 5 per cent one-side test based on the VARHAC procedure described in Den Haan and Levin (1997). We follow the tradition and set the smoothing parameter of the HP filter equal to 1600. BK indicates the frequency-domain filter of Baxter and King (1999). Bold characters highlight the highest cross-correlation coefficients.

Next, we conduct similar analysis on quarterly data to ensure consistency in findings. As in the case of the monthly data, first, the cross-correlation analysis is conducted on the output growth and inflation rate. As shown by panel A of Table 2, the results consistently show that the correlation coefficients are significant negative for all the three sample periods. However, unlike the case of monthly data where there are lags in the correlation of coefficient, using the quarterly data suggest that there is an instantaneous relationship between output and price. This is consistent with the frequency of the data which is quarterly in nature. Applying the HP and BK filters on output and price, however, yield weaker evidence on the nature of output-price relationship. In particular, when the HP filter is used, the result shows a significant negative (-0.13) with lag for the whole sample period of 1971M1-2009M11. For the other sub-sample periods, there are no indications of significant cross-correlation coefficients. Meanwhile, when the BK filter is applied, the results show significant negative (-0.07) with a lag only for the 1980M1-2009M11 period.

Table 2: Cross-correlation with filters (monthly data)

	-3	-2	-1	0	1	2	3
Panel A:	Correlation of output growth and Inflation $COR(\Delta y_t, \Delta p_{t+k})$						
1971M1-2009M11	0.03	0.04	-0.02	-0.14*	0.04	0.01	-0.01
1980M1-2009M11	0.05	0.04	-0.04	-0.19*	0.04	-0.02	-0.03
1990M1-2009M11	0.07	0.07	-0.05	-0.15*	0.06	-0.04	0.02
Panel B:	Correlation of HP-filtered output and price $COR(y_t^{hp} p_{t+k}^{hp})$						
1971M1-2009M11	-0.13*	-0.12	-0.12	-0.13	-0.10	-0.07	-0.05
1980M1-2009M11	-0.11	-0.11	-0.12	-0.14	-0.11	-0.09	-0.06
1990M1-2009M11	-0.02	0.00	0.00	-0.02	0.02	0.05	0.07
Panel C:	Correlation of BK-filtered output and price $COR(y_t^{bk} p_{t+k}^{bk})$						
1971M1-2009M11	0.04	0.01	-0.06	-0.10	-0.02	0.03	0.05
1980M1-2009M11	0.07	0.02	-0.07*	-0.13	-0.04	0.01	0.05
1990M1-2009M11	0.14*	0.12	0.02	-0.02	0.07	0.09	0.12

Notes: * indicates a coefficient is significantly different from zero using a 5 per cent one-side test based on the VARHAC procedure described in Den Haan and Levin (1997). We follow the tradition and set the smoothing parameter of the HP filter equal to 129600. BK indicates the frequency-domain filter of Baxter and King (1999). Bold characters highlight the highest cross-correlation coefficients.

4.2 Co-movements with VAR forecast errors

In this section, we use the VAR forecast errors procedures (as discussed in section 3.2) to analyze the co-movement between output and price in Malaysia for the time span under consideration. The co-movement between output and price is described using the correlation coefficients of VAR forecast errors at different forecast horizons as proposed in Den Haan and Sumner (2000). Correlation coefficients of forecast errors are estimated based on VARs that only include output and price.

First, the VAR's for the data in levels, that is, without imposing the unit root restriction, are estimated. Time series of output and prices are viewed as non-stationary variables.[†] In order to assess the robustness of the empirical results of VAR in level, we estimated the VAR using first differences, which is we imposed the unit root in the estimation. The characteristics of the VAR's in levels are described in Table 3. The AIC and SIC are used to determine the number of lags and whether linear and quadratic deterministic trend terms should be included. Qualitatively, the results are similar for these two alternative order selection criteria. Hence, to conserve space, only the results based on VAR's length determined by the AIC are reported in this paper.

[†] We have conducted unit root tests of ADF, PP and KPSS, however the results are mixed. We proceed by assuming they are all the variable are integrated of order one. The results are available upon request.

Table 3: Characteristics of estimated bi-variate VAR's[‡]

Sample period	Unit Root Imposed	No. of lags	Linear Trend	Quadratic Trend
Monthly Data				
	No	4	Yes	Yes
1971M1 – 2009M11	Yes	3	Yes	No
Quarterly Data				
	No	8	Yes	Yes
1970Q1- 2009Q3	Yes	5	Yes	No

Intuitively, the covariance and correlation coefficients of output and price are estimated by measuring the difference between the actual (realized) values and the corresponding expected (forecast) values, which are forecast errors, from one quarter to 28 quarters of forecast periods. Since the estimated correlation coefficients are subject to sampling variation, confidence bands are constructed using bootstrap methods. More specifically, for each estimated VAR and its bootstrapped errors are used to generate 2500 simulated data sets. Then, for each simulated data set, the correlation coefficients at different horizons are estimated and standard confidence bands are calculated.

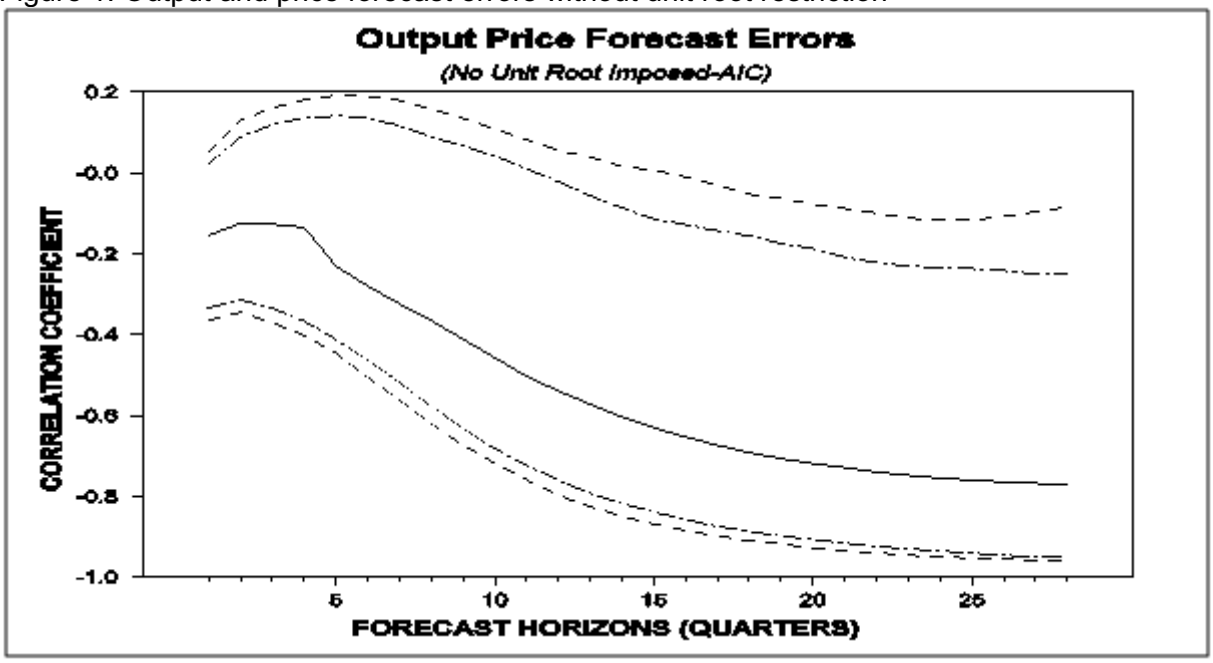
The results of the output-price forecast errors which is estimated based on the VAR are shown in Figures 1 and 2. Each graph shows the estimated correlation coefficients (solid line), the 10 percent - 90 percent (dots and dashed lines) and 5 percent - 95 percent (dashed lines) confidence bands constructed using bootstrap methods with 2500 replications. In general, both the quarterly and monthly data reveals that Malaysia exhibits a significant negative long-run co-movement between output and prices.

Figure 1 displays a set of graphs analyzed without unit root imposed. The results show that the long-run correlation between output and price is negative and significant based on both the quarterly and monthly data, with clearer evidence provided by the quarterly data. This results complement the earlier findings based on the cross-correlation analysis, that the correlation between output and price is negative and significant.

Figure 2 displays the graphs showing the estimated correlation coefficients and the corresponding confidence bands for Malaysia by imposing the unit root restriction. Comparing Figures 1 and 2, we observe that the long-run correlation between output and price is still negative, but the negative long-run correlations are no longer significant. This result is in line with that of Vázquez (2002) which documents that France, Germany, Italy and UK exhibit significant negative long-term correlation coefficients when the unit root restriction is not imposed, whereas the long-term negative correlation coefficients are not significant for Italy when the unit root is imposed.

[‡] Initially, we plan to investigate is there any difference in the correlation between output and price before and after Asian financial crisis, however, it has an important drawback as it implies the sample size reduces dramatically.

Figure 1: Output and price forecast errors without unit root restriction



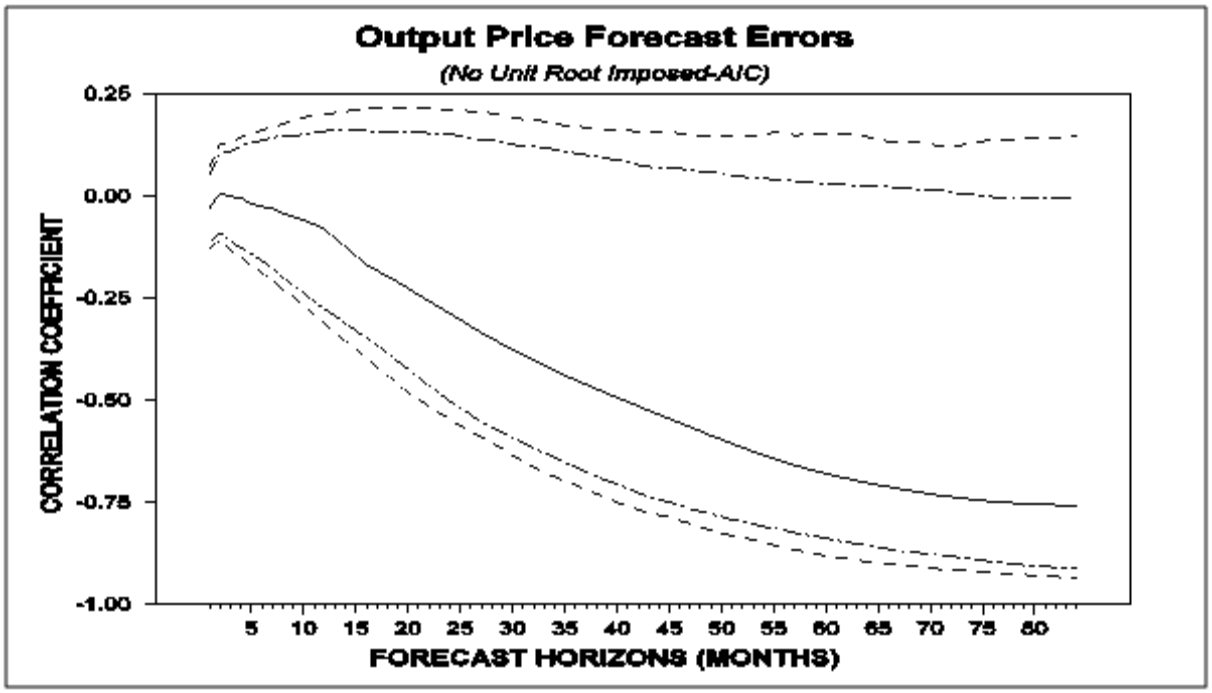
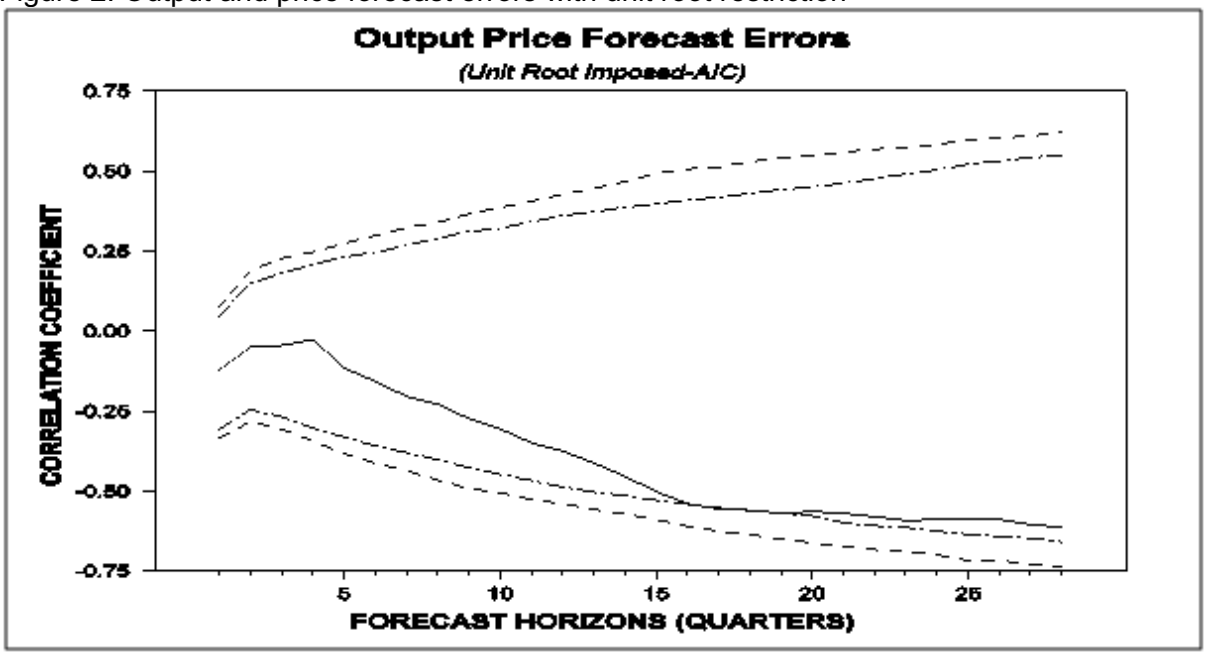
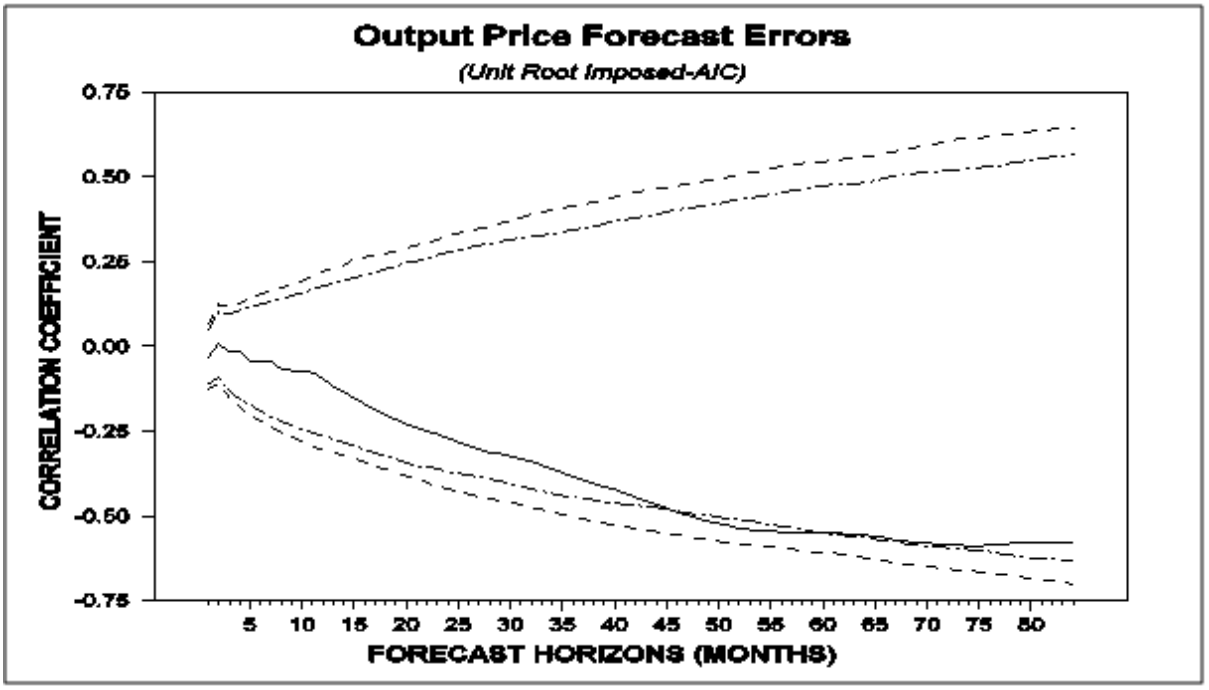


Figure 2: Output and price forecast errors with unit root restriction





5. CONCLUSION AND POLICY RECOMMENDATIONS

With the aim of providing updated and conclusive evidence on the nature of output-price relationship in the Malaysian economy, this study adopts both the cross-correlations coefficients of de-trended series and correlation coefficients of forecast errors at different forecast horizons obtained from estimated VAR as suggested by Den Haan and Sumner (2000). These approaches are highly suitable in the context of this study due to two major advantages. First, a better description of the dynamic relationship between the variables is obtained compared to when the focus is only on the unconditional correlation coefficient. Second, the method can be implemented when the variables are either stationary or integrated processes, which rendered the de-trending process of the data as unnecessary.

The study documents consistent empirical evidences of negative relation between output and price in the Malaysian case. Furthermore, there are significant negative long-term correlation coefficients when the unit root restriction is not imposed, whereas the long-term negative correlation coefficients are not significant when the unit root is imposed. In view of the conclusive findings, the study proposes that macroeconomic policy which favors the supply side of the economy is more suitable in the case of this country as the relationship between output and price points towards the importance of supply shocks in influencing the economic cycle in Malaysia.

As such, macroeconomic policy should consider and be supportive of the production side of the economy. While stimulating the demand or consumption side of the economy could be part of the macroeconomic strategy, the findings of this study reveal that in formulating macroeconomic stabilization policy, priority should be given to the production sector of the economy. This includes providing conducive environment for greater economic activity of the production sector such as lowering corporate taxes and lowering the trade barriers to reduce the cost of doing business in the country. Strategies to ensure stable prices of input or raw materials are highly recommended. In relation to this, it is important to ensure stable energy prices so that the production process will not be adversely affected, thus giving an impact to the economic output. Similarly important is to continue to improve labor productivity by way of adoption of new technology and increasing the quality of labor, just to name a few.

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