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Rifai Afin
Corvinus University of Budapest, rifaiafin22@gmail.com

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INTERLINKAGE OF MACROECONOMIC UNCERTAINTY AND MACROECONOMIC PERFORMANCE: EVIDENCE FROM ASEAN-5 COUNTRIES PANEL VAR

Rifai Afin

Corvinus University of Budapest, Universitas Trunojoyo Madura. Email: rifaiafin22@gmail.com

ABSTRACT

This paper examines the interrelationship between inflation, inflation uncertainty, growth, and growth uncertainty. We find a negative effect of output uncertainty on output growth and a positive effect of output growth on output uncertainty. Inflation uncertainty has a negative effect on the inflation rate, suggesting that there is a stabilizing motive during high periods of high inflation, where the policy lowers inflation uncertainty to minimize the economic welfare costs of deflationary actions. However, inflation has a positive effect on inflation uncertainty suggesting that agents may devote more resources to inflation forecasting in a rising inflation environment, which reduces uncertainty. We also find a negative relation between inflation and growth, suggesting that a moderate trend of growth and inflation should be maintained to achieve desirable effects on the economy.

Keywords: Inflation; Growth; Uncertainty; Panel EGARCH; Panel VAR.
JEL Classifications: C33; E31; E32.

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I. INTRODUCTION

The economic perspectives of uncertainty may arise from the constraint on agents to understand exactly what will and will not happen in the future situation or in another world. Jurado *et al*. (2013) defined it as unpredictable disturbance. This disturbance can create doubts about agent's economic decision, such as investment and consumption. Unfortunately, the fact is the objectives of macroeconomic policy, namely inflation stability and growth are difficult to achieve due to uncertainty (Fountas *et al*., 2006).

There is a growing number of empirical studies that attempt to examine the bilateral relationship between inflation uncertainty and inflation rate and come up with contradictory results. Ali and Mehdi (2016) summarize many studies on inflation and inflation uncertainties whose results can be classified into four categories. First, Friedman (1977) and Ball (1992) known as Friedman-Ball Hypothesis argue that higher inflation promotes inflation uncertainty. Second, a group of studies supports the Pourgerami and Maskus (1987) argue that higher inflation reduces inflation uncertainty known as Pourgerami-Markus Hypothesis. The third study is that of Cukierman and Meltzer (1986), which shows a contradictory causal effect of inflation and inflation uncertainty, as described earlier, namely that inflation affects inflation uncertainty, which can be positive or negative. Cukierman and Meltzer's hypothesis states that there is a positive causal relationship between inflation uncertainty and inflation rate. Fourth, Holland Hypothesis of Holland (1995) argues against the Cukierman Meltzer hypothesis, which holds the notion that inflation uncertainty can lower the inflation rate. Nevertheless, there is some empirical evidence that there is no relationship between inflation uncertainty and inflation rates (Bailie *et al*., 1996; Daal *et al*., 2005).

Inflation, inflation uncertainty, growth and growth uncertainty are interrelated. Inflation uncertainty affects output growth. Friedman (1977) and Dotsey and Sarte (2000) conclude that inflation uncertainty has negative and positive effects on growth respectively. On the other hand, Devereux (1989), Cukierman and Gerlach (2003) support the positive effect of output uncertainty on inflation, while Taylor effect and Cukierman and Meltzer (1986) assert the negative role of output uncertainty on inflation. Moreover, Bernanke (1983), Pindyck (1991), Ramey and Ramey (1991) show a negative effect of output uncertainty on output growth, but Black (1987), Blackburn (1999) argue the opposite relationship.

Bredin and Fountas (2005) analyze inflation, uncertainty, and output and conclude that macroeconomic uncertainty can improve economic performance. Fountas *et al*. (2006) examine how these four variables interact and find that there are significant relationships between these four variables, although results differ across G7 countries. Bhar and Mallik (2012) also examine the relationship with additional concern about oil price fluctuations in the UK and find a significant relationship. Akinsola and Odhiambo (2017) provide a literature review on the relationship between inflation and growth in both developed and developing countries and find that there is variation in conclusions across countries and over time. Moreover, the uncertainty of inflation and growth contributes to the ineffectiveness of monetary policy (Caggiano *et al*., 2017).

This study aims to identify the interaction between inflation, growth and uncertainty in Southeast Asian countries through panel data analysis. Although

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ASEAN-5 countries share many similarities, they differ in ways that could affect the relationship between inflation and inflation uncertainty. The independent monetary and fiscal policy among countries, trade diversions, and economic structure may play role in the construction of varied macroeconomic performance in ASEAN countries. In addition, there are significant gaps among the members, such as economic size, and productivity. Due to such gaps in macroeconomic performance and the mismatch between economic value and size, ASEAN's economic cooperation is fragile (Verico, 2017). This raises the question of whether they have similar relationships between inflation and inflation uncertainty and how inflation and inflation uncertainty affect growth and growth uncertainty. The prevalence of this effect could have a great impact on the performance of ASEAN countries, as the ASEAN Economic Society in 2015 allowed ASEAN countries to become more integrated. Hill and Menon (2010) argue that ASEAN is the most maintained and successful regional grouping in the developing world. Consistent to Hill and Menon (2010), Ishikawa (2021) evaluates the integration of ASEAN and argues that ASEAN is an example of successful integration among developing countries because it implements liberalization over time. As a result, the economic activities of each country could have a greater impact. In this case, a panel data study provides a more general conclusion on this topic because of the existing time series studies on the ASEAN case such as Jiranyakul and Opiela (2010) who focus on inflation and inflation uncertainty, Mohd *et al*. (2013) who focus on inflation, growth and uncertainty when analyzing individual countries, and Thanh (2015) who examines the relationship between inflation and growth using a panel data structure. There are not many studies that deal with the simultaneous interaction between inflation, growth and their uncertainty, more so in the context of a panel data analysis. One study that uses panel analysis is Lee (2009), who analyzes the relationship between output growth and its uncertainty using Generalized Auto Regression Conditional Heteroscedasticity (GARCH) on panel data for G7 countries. Meanwhile, there is no previous study that examines the interaction of all four variables with a panel data structure. This study has the advantage of being generalizable, as the analysis of individual countries seems to offer a greater variety of results. One of the advantages of using panel data instead of a single time series is that the asymptotic distributions of the test statistics in panel data are asymptotically normally distributed and are not the same as unconventional distributions. They are approximately normally distributed for samples of a size typical of financial data (Bakry, 2006), which are typically high-frequency data supporting this study that uses monthly observations.

This study performs a two-stage analysis. First, Panel Exponential GARCH (PEGARCH) is applied to measure the conditional volatility of inflation and growth as an indicator of uncertainty. Second, Panel Vector Auto Regression (PVAR) developed by Abrigo and Love (2016) is employed to identify the interaction between inflation, growth and their uncertainty. The structural form of the PVAR model accounts for the endogenous problem that may lead to bias in estimating the relationship between inflation, growth and their uncertainty.

This study shows that output uncertainty has a negative impact on output growth and that output growth has a positive impact on output uncertainty. Inflation uncertainty, on the other hand, has a negative effect on the inflation rate. Nonetheless, inflation has positive effects on inflation uncertainty. On the other hand, inflation has a negative effect on growth as it symbolizes the risks of future investment. The data show how the combination of growth, inflation and their uncertainty seem to cancel each other out, which could be due to a feedback effect (Lin and Kim, 2013), nonlinearity (Chowdhury *et al*., 2020) and endogeneity (Chen *et al*., 2015; Ludvigson *et al*., 2018). The cross-interaction shows that growth and inflation interact to illustrate that inflation affects economic growth and high growth can lead to inflation. Accordingly, the stabilization policy among ASEAN countries should be maintained to achieve the desirable economic performance.

This paper is organized as follows: Section II reviews the literature examining the relationship between inflation, growth, inflation uncertainty, and growth uncertainty. Section III presents the methodology, which consists of the description of the data and the econometric techniques used, panel data analysis. Section IV provides and discusses the empirical results. Section V provides concluding remarks.

II. LITERATURE REVIEW

This section will be divided into two sessions, namely a review of theory and empirical studies. In the theoretical section, it is explained how the relationship between four variables, namely inflation, growth, and inflation uncertainty and growth uncertainty is explained.

A. Theoretical Review

The effect of Inflation on inflation's uncertainty: Friedman (1977) and Ball (1992) note that high inflation generates political pressure to reduce it, whereas some policymakers may be hesitant to pursue disinflationary policies due to concerns about the probability of coming to a recession. As a result, as current inflation rises, the public becomes increasingly concerned about future inflation. In other words, the policymakers' response in the coming period is unknown. As a result, higher inflation raises uncertainty about future growing money supply and, consequently, future inflation, which is known as the Friedman-Ball Hypothesis. But, according to Pourgerami and Maskus (1987), economic agents (consumers and producers) can invest more resources to predict inflation, so increasing inflation is assumed to be correlated with a lower average of future inflation. This argument is popularly recognized as the Pourgerami-Maskus Hypothesis, implying a negative causal effect from inflation-to-inflation uncertainty.

The effect of inflation uncertainty on Inflation: Cukierman and Meltzer (1986) demonstrate that during times of greater uncertainty, the monetary authority has a greater incentive to stimulate output by shocking monetary policy, and therefore, they use discretionary policy rather than the rule policy mechanism. Higher inflation uncertainty may raise the average inflation rate. The Cukierman-Meltzer Hypothesis describes the positive causal effect of inflation uncertainty on inflation. In contrast to the previous hypothesis, Holland (1995) proposes a different idea which is based on the monetary authority's motivation to stabilize the economy. He claims that the central bank's stabilization intention is determined by the welfare cost of inflation uncertainty. When higher inflation causes an increase in inflation uncertainty, the welfare cost increases. As a result, the monetary authority responds by slowing money supply growth in order to eliminate inflation uncertainty and the associated negative welfare effects. Increased inflation uncertainty lowers the average inflation rate. The Holland Hypothesis refers to the negative causal effect of inflation uncertainty on the inflation rate. It is also known as the Stabilizing Fed Hypothesis because the negative causal effect is evidence of a motive of central bank stabilization policy.

The effect of inflation uncertainty on growth: according to Friedman (1977), inflation uncertainty has a negative impact on output. This result is based on the idea that uncertainty about future inflation disturbs the price mechanism's allocative efficiency. In particular, inflation uncertainty influences both through its effect on interest rates and its effect on relative prices in the existence of nominal rigidities. Economic agents need clear signals to make effective decisions and act efficiently under the price expectations. Nevertheless, the real value of future assets, payments, and income is uncertain due to inflation uncertainty. It causes producers to be uncertain about real profit revenue, consumers to be uncertain about how much they should pay, and tenants and landlords to be uncertain about real rents, potentially disturbing these agents' decisions. Uncertainty about inflation raises the riskiness of real returns on financial assets and instruments.

The impact of inflation uncertainty on economic growth is also reflected in the impact on investment performance. Some theories (Pindyck, 1991) focus on the irreversibility factors of investment and arguments of investment as preceding investment opportunities in the future. As a result, the value of this missed opportunity represents the opportunity cost of an investment project. Inflation uncertainty creates uncertainty about the potential returns of investment projects, providing an incentive to postpone them or even cancel them, playing the role the low investment level and economic growth. Dotsey and Sarte (2000) provide a rather perplexing result: increased inflation uncertainty can increase output. This outcome is the result of a precautionary motive and the assumption of risk-averse agents: increased inflation uncertainty raises savings, consequently, it raises investment and growth.

The effect of inflation on economic growth: the Philips curve explains how the increase in nominal wages is negatively correlated and the pattern of this relationship can be non-linear although this is later debated, and the concept of NAIRU (Non-Accelerating Inflation Rate of Unemployment) emerged. In the Phillips curve, when the demand for labor is high and there is relatively little unemployment, firms try to increase wages to get the labor they want, and as long as this wage rate is below the wage level desired by workers, workers will resist. On the other hand, if the demand for labor is low and unemployment is high, the wage rate will be relatively slow to fall. In other words, when output growth is higher than natural output, inflation will be triggered.

Inflation also deteriorates the market situation in the long-run macroeconomic condition by reducing the efficiency with which factors are employed. This mechanism, also known as the efficiency of the market mechanism, is more difficult to formalize in a theory; nevertheless, its importance in the transmission mechanism from inflation to lower economic growth cannot be exaggerated. A high inflation rate yields changes in price lists, which can be expensive for producers and diminish consumers' optimal money cash in hand. It also creates larger forecast disturbance by distorting the information related to prices, encouraging economic agents to spend more time and resources gathering information and protecting themselves from the costs of price volatility. Andrés and Hernando (1997). On the other side, Briault (1995) contends that, at least in the short run, there is a positive relationship between growth and inflation, with the direction of causation running from higher growth to higher inflation. Economists in the structuralist tradition have sometimes argued that moderate inflation rates are potentially beneficial for growth (Fountas *et al.,* 2006)

Output uncertainty and inflation uncertainty: The concept of the relationship between growth uncertainty and inflation uncertainty is explained brilliantly by Cecchetti and Ehrmann (2001) and Cecchetti *et al.* (2004) who explain the relationship between these two variables in the context of monetary policy. Both variables are targets of optimal monetary policy in which low inflation and output variability are expected outcomes. The trade-off between the two makes monetary policy difficult to be efficient. This approach is known as the monetary policy frontier.

The construct of an inflation-output volatility frontier is best learned easily by imagining a simple economy subjected to two types of distortions, both of which may necessitate policy interventions. These are aggregate demand shocks, driving growth and inflation in the same direction, and aggregate supply shocks, which drive output and inflation in opposite directions. Inflation runs in opposite directions because the monetary policy has the ability to influence growth and inflation, It can completely cancel out aggregate demand shocks if they are in the same direction. In comparison, aggregate supply shocks will force the central bank to choose between the variability of supply and the variability of economic growth as well as inflation.

B. Empirical Studies

There is a growing body of empirical work that attempts to analyze the bidirectional relationship between inflation uncertainty and inflation rate, with mixed results. Ali and Mehdi (2016) find there are different conclusions from studies on the relationship of inflation and inflation risks. However, other empirical evidence such as Bailie *et al*. (1996), Daal *et al*. (2005) show that there is no relationship between inflation uncertainty and inflation rates, suggesting the need for further investigation.

Unlike previous studies, Grier *et al*. (2004) use monthly U.S. data and employ VARMA as a simultaneous approach to capture the relationship between inflation, growth, and their uncertainty, and use GARCH as the mean to measure the uncertainty of both inflation and growth. The study shows that higher growth uncertainty is correlated with higher output growth. Moreover, inflation uncertainty has a negative effect on average growth and higher inflation uncertainty leads to lower inflation rates. Bredin and Fountas (2005) analyse the typical case of G7 countries and find that in most countries (six out of seven countries) output growth uncertainty positively affects output growth. In the US, there is support for the Black hypothesis that growth uncertainty increases growth and for the Friedman hypothesis that inflation uncertainty negatively affects output growth. On the other hand, there is mixed evidence on the impact of output uncertainty on inflation. The inconsistent results of the studies are possible because the methodological approach adopted in measuring the conditional variance or standard deviation using uncertainty models such as GARCH is case-dependent. Shields *et al*. (2005) find that inflation uncertainty is a determinant of output uncertainty. Moreover, higher growth fluctuation tends to lead to higher inflation uncertainty. Inflation and growth uncertainty respond asymmetrically to positive and negative shocks. The other studies by Bhar and Mallik (2012) suggest that inflation uncertainty increases inflation, however, the effect of inflation uncertainty on inflation is negative after inflation targeting. On the other hand, growth uncertainty reduces inflation and increases growth and oil price has a positive effect on inflation but not on growth.

Some complexities of the interrelationship among inflation, growth and their uncertainty are the emersion of problem of nonlinearity among inflation, uncertainty, and output growth, as indicated by Chowdhury *et al*. (2020), Chen *et al*. (2015), Cohen-Cole *et al*. (2012), asymmetric relationship by Jovanovic and Ma, (2020), and endogeneity (Ludvigson *et al*., 2018) which may result in feedback effect (Lin and Kim, 2013). As consequence, identification of interlinkage among inflation, growth and uncertainty may not be easy. For a summary of selected existing studies, please refer to Table 1.

Table 1.
Existing Studies on Inflation, Output, and Uncertainty

Table 1 provides an overview of the papers that have examined the relationship between inflation, uncertainty and growth simultaneously which are different from previous studies that are concerning only two variable interaction either inflation and inflation uncertainty, or growth and growth uncertainty.

No	Authors	Techniques	Data	Results
1	Grier *et al*. (2004)	VARMA (Vector Auto regression Moving Average) and GARCH-M	Monthly data US producer price index and industrial production index.	Increased growth uncertainty contributes significantly lower average growth. Higher inflation uncertainty is significantly negatively connected to lower output growth and lower mean inflation.
2	Shields *et al*. (2005)	VARMA and GARCH-M with Generalized Impulse Response Function (GIRF)	Monthly data from April 1947-October 2000 using producer price index and industrial production index	Inflation uncertainty is a determinant of output uncertainty. Higher growth fluctuation tends to push inflation uncertainty. Inflation and growth uncertainty react asymmetrically to positive and negative shocks.
3	Bredin and Fountas (2005)	VARMA and GARCH-M	Monthly data G7 Countries. Industrial Production Index as Output, and Consumption Price Index as price level	Output Growth Uncertainty has positive effect on Output Growth. Mixed evidence of the effect inflation uncertainty on output growth and output uncertainty on inflation. Macroeconomic uncertainty may improve economic performance.

Table 1.
Existing Studies on Inflation, Output, and Uncertainty (Continued)

No	Authors	Techniques	Data	Results
4	Bhar and Mallik (2012)	EGARCH and VAR	Monthly and quarterly data of Producer Price Index as price indicator and Industrial production index as output	Growth uncertainty significantly determines the changes of growth, growth uncertainty, inflation, and inflation uncertainty. Growth uncertainty deteriorates economic growth and pull up inflation and inflation uncertainty
5	Baharumshah *et al*. (2016)	Standard deviation of inflation as a measure uncertainty, and System Generalized Method of Moment	94 developing and emerging economies annually	Inflation reduces growth, and inflation uncertainty increases growth in non-inflation crisis countries. positive effect of inflation uncertainty on growth when inflation achieve a moderate range
7	Shah *et al*. (2019)	Baba, Engle, Kroner, and Kraft (BEKK) version of Engle and Kroner (1995), VAR(p) BEKK	Monthly data of inflation and industrial production index	inflation positively affect inflation uncertainty. negative influence of uncertainty on inflation rate no effect of macroeconomic uncertainty on growth growth negatively affects growth real uncertainty. no bidirectional effect on real and nominal uncertainty
8	Bicchal and Durai (2020)	Uncertainty indices, and VAR model	Quarterly data of emerging economies and India	The findings reveal that US uncertainty has a significantly greater impact than local uncertainty, implying that worry in the Indian economy has a major worldwide spillover effect.
9	Živkov *et al*. (2020)	GARCH-M and EGARCH and Bayesian quantile regression framework	Quarterly time series data, central and eastern European countries	That inflation has a much less negative impact on GDP growth than inflation uncertainty, confirming the Friedman theory. This suggests that inflation has an indirect impact on GDP growth in the selected nations due to inflation uncertainty.
10	Coibion *et al*. (2021)	Randomized Control Trial (RCT)	European Central Bank's Consumer Expectation Survey (CES)	the impact of aggregate uncertainty on spending being predominantly driven by households working in more cyclically sensitive industries.

III. METHODOLOGY

A. Data Description

For the analysis, data from Global Economic Monitoring (GEM) are provided by the World Bank from January 2000 to February 2020. Consumer Price Index (CPI) and Industrial Production constant Value (IPV), base year 2010, which represent price and output respectively, both variables are seasonally adjusted monthly. In this study, 5 ASEAN countries were considered, namely Indonesia, Malaysia, Thailand, Singapore and the Philippines. For the other ASEAN countries, complete series are not available at GEM and the data from each national institution are not compatible as there are different base years for the calculation. For all 5 countries, complete and balanced time series are available for the period from January 2000 to February 2020, so there are 242 individual series and 5 country units. The calculation of the inflation and growth variables follows some related previous studies such as Bredin and Fountas (2005), Ferreira and Palma (2017), Fountas *et al*. (2006) and Huizinga (1993). The price variable is denoted by π, derived from the natural logarithm of the ratio between CPI at time t and CPI at time (t-1), $\pi = 100 * \ln(\frac{CPI_t}{CPI_{t-1}})$, whereas output growth is denoted by y which can be measured by ratio of IPV at time *t* with IPI at time *t*-1, as $y = 100 * \ln\left(\frac{IPI_t}{IPI_{t-1}}\right)$. The summary statistics of the raw data of CPI, IPV, and generated variable that are used in the model, π, and y, are reported in Table 2. Table 2 shows that Indonesia has the highest π and y values, while Singapore has the opposite position, with the lowest π values but relatively high y values. This study generalizes these relationships in a panel data set for ASEAN countries.

Table 2.
Summary Statistics of Variables

This table summarizes observations used in this study. Data are collected from Global Economic Monitoring (GEM, monthly series), $\pi = 100 * \ln(\frac{CPI_t}{CPI_{t-1}})$, and $y = 100 * \ln\left(\frac{IPI_t}{IPI_{t-1}}\right)$, CPI denotes Consumer Price Index, and IPV denotes Industrial Production Index, 2010 base year. Source: Author's calculation

	Variable	Mean	Std. Dev.	Min	Max	Observations
Indonesia	*CPI*	100.348	34.900	43.877	157.255	N = 242
	IPV	2.88	6.26	1.58	4.27	N = 242
	π	4.610	0.006582	4.598	4.685	N = 241
	y	4.609	0.050438	4.37988	4.861	N = 241
Malaysia	*CPI*	100.450	13.727	80.382	122.938	N = 242
	IPV	8.740	1.66	5.760	1.210	N = 242
	π	4.606	0.00383	4.594	46.421	N = 241
	y	4.608	0.0257025	4.515	46.890	N = 241
Philippines	*CPI*	97.85278	21.374	61.623	134.211	N = 242
	IPV	7	1.38	4.150	1.070	N = 242
	π	4.6084	0.0033005	4.599	4.630	N = 241
	y	4.606926	0.0407922	4.409	4.748	N = 241

Table 2.
Summary Statistics of Variables (Continued)

	Variable	Mean	Std. Dev.	Min	Max	Observations
Singapore	*CPI*	102.0204	12.00696	85.88662	117.072	N = 242
	IPV	5.36	1.55	2.72	8.400	N = 242
	π	4.606456	0.0035892	4.594277	4.620	N = 241
	y	4.608253	0.072315	4.358421	4.866	N = 241
Thailand	*CPI*	98.42047	129.7993	77.47058	114.8749	N = 242
	IPV	1.11	2.41	5.93	1.39	N = 242
	π	4.606786	0.0039228	4.57883	4.623261	N = 241
	y	4.608353	0.0427369	4.323071	4.799138	N = 241

B. Econometric Estimation

The estimation strategy of this study is divided into three stages. First, inflation and output uncertainty are measured by the conditional heteroskedasticity of π and y. Some studies proposed conditional panel heteroskedasticity, ARCH and GARCH, such as Kitazawa (2000), Cermeno and Grier (2001), Lee (2010), Arneric and Peric (2018). This paper generally follows Cermeno and Grier (2001) as the proposed strategy fully considers the conditions of the data process. They proposed 4 strategic models, namely the pooled model, the fixed effects panel at the mean with the pooled GARCH model, the pooled mean model with fixed effects in the GARCH model, the fixed effects panel at the mean, and the GARCH model. However, some changes and adjustments to the terms are being made. In this paper, the mean equation is first estimated as follows.:

$$\pi_{it} = \mu_i + \beta_1 DInd_{it} + \beta_2 DMalDMal_{it} + \beta_3 DTha_{it} + \beta_4 DPhi_{it} + \sum_{k=1}^{K} \alpha_k \pi_{i,t-k} + \epsilon_{it} \tag{1}$$

$$y_{it} = \theta_i + \beta_1 DInd_{it} + \beta_2 DMalDMal_{it} + \beta_3 DTha_{it} + \beta_4 DPhi_{it} + \sum_{j=1}^{J} \delta_j y_{i,t-j} + \omega_{it} \tag{2}$$

where μ and θ denotes constant term, β and γ capture possible country specific effect represented by dummy variables which Dind, DMal, DTha, and Dphi as dummy variable for Indonesia, Malaysia, Thailand, and Philippines respectively. α and δ are coefficients of lag of auto regression variables, while ε and ω are error disturbance which are assumed to be zero mean and normally distributed. The additional assumptions for the equation 1 and 2 are no contemporaneous correlation ($E[\varepsilon_{it}\varepsilon_{js}]=0$) for $i\neq j$ and $t\neq s$), no auto correlation among the time series components, ($E[\varepsilon_{it}\varepsilon_{js}]=0$) for $i=j$ and $t\neq s$), and conditional variance, ($E[\varepsilon_{it}\varepsilon_{js}]=\sigma^2_{ij,t}$) for $i\neq j$ and $t=s$), and conditional covariance, ($E[\varepsilon_{it}\varepsilon_{js}]=\sigma^2_{it}$) for $i=j$ and $t=s$). The next step is to estimate the conditional variance following GARCH (1.1). Previous studies using the panel GARCH model proposed by Cermeno and Grier (2001) using the maximum likelihood function based on the assumption that $\epsilon_{it}=\sigma z_t$ where z_t follows standardized Gaussian distribution as follows:

$$l = -\left(\frac{NT}{2}\right) ln(2\pi) - \left(\frac{1}{2}\right) \sum_{t=1}^{T} ln|\Omega_t| - \left(\frac{1}{2}\right) \sum_{t=1}^{T} (y_t - \mu - Z_t\theta)'x\Omega_t^{-1}(y_t - \mu - Z_t\theta) \quad (3)$$

where Ω_t is time dependent and its diagonal and off diagonal components that are given by equation 4.

$$\sigma_{it}^2 = \varphi_i + \tau\sigma_{it-1}^2 + \lambda\epsilon_{i,t-1}^2 \quad i = 1, \ldots\ldots N \quad (4)$$

where σ_{it}^2 is the conditional variance of the mean equation (1) and (2) while ϵ_{it} and ω_{it} are error disturbance of the two mean equations. Equation (4) is the GARCH model which constrain the coefficient of the model into positive and the sum of the coefficient is equals or less than 1. The reason behind this is to restrict non-negativity the parameter of variance and stationarity that probably not be fulfilled using unrestricted parameterization (Enders, 2015). Nevertheless, initiated by Black (1976) providing empirical evidence that there is negative relationship of current returns and future returns uncertainty of stock prices, moreover, Nelson (1991), and Bollerslev and Mikkelsen (1996), argues that GARCH model assume that only the magnitude and not expected sign neither positive nor negative in determining variance. By estimating the equation (4), we get GARCH effect of the mean equation. This paper uses overall mean of sample to proxy α_0 and choose moderate value from general ARCH model specification and assume that the value of the first period conditional variance is the same as the value of long-term variance which is shows by variance of observation sample. This study tries to deal with the solution of restriction and non-negativity in the model (4) by using Panel Asymmetric Exponential GARCH initially based on study by Nelson (1991) in which there is no impose on negativity constraint. Instead of using equation (4) we use as follows:

$$log\ (\sigma_{it}^2) = \alpha_0 + \beta log\sigma_{it-1}^2 + \alpha \left|\frac{\varepsilon_{it-1}}{\sigma_{it-1}^2}\right| + \theta \frac{\varepsilon_{it-1}}{\sigma_{it-1}} \quad (5)$$

where θ is the asymmetric coefficient, β is the GARCH effect, and α is the parameter of absolute ratio of error and conditional variance. The second goal of this study is to estimate the behavior of the relationship between inflation, output, and their uncertainty. Panel Vector Auto Regression (PVAR) is employed to investigate the interaction among those four variables. PVAR estimation initially developed by Holtz-Eakin *et al*. (1988). The estimation model for this study contains four endogenous variables that be written as follows:

$$Y_{it} = Y_{it-1}A_1 + Y_{it-2}A_2 + \ldots + Y_{it-p+1}A_{p-1} + Y_{it-p}A_p + X_{it}B + u_i + e_{it}$$
$$i\epsilon\{1,2,\ldots,N\},\ t\epsilon\{1,2,\ldots,T\} \quad (6)$$

Y_{it} denotes (1xk) endogenous variables vector, X_{it} represents a (1x1) vector of exogenous variables, where u_i and e_{it} are the dependent variable specific panel fixed effect and idiosyncratic error. (kxk) matrices $A_1, A_2, \ldots A_{p-1}, A_p$ and matrix B (1xk) are estimated parameters. Abrigo and Love (2016) assume that the innovations characterised by $E(e_{it})=0$, $E(e'_{it}, e_{it})=\sum$, and $E(e'_{it}, e_{it})=0$ for t > s.

$$\pi_{it} = \alpha_{10} + \sum_{p=1}^{T} \psi_{it}\pi_{i,t-p} + \sum_{p=1}^{T} \Phi_{it}y_{i,t-p} + \sum_{p=1}^{T} \Omega_{it}\sigma^2_{i\pi t-p} + \sum_{p=1}^{T} \varsigma_{it}\sigma^2_{iyt-p} + u1_i + e1_{it} \quad (7)$$

$$y_{it} = \alpha_{20} + \sum_{p=1}^{T} \psi_{it}\pi_{i,t-p} + \sum_{i=1}^{T} \Phi_{it}y_{i,t-p} + \sum_{p=1}^{T} \Omega_{it}\sigma^2_{i\pi t-p} + \sum_{p=1}^{T} \varsigma_{it}\sigma^2_{iyt-p} + u2_i + e2_{it} \quad (8)$$

$$\sigma^2_{\pi it} = \alpha_{30} + \sum_{p=1}^{T} \psi_{it}\pi_{i,t-p} + \sum_{p=1}^{T} \Phi_{it}y_{i,t-p} + \sum_{p=1}^{T} \Omega_{it}\sigma^2_{i\pi t-p} + \sum_{p=1}^{T} \varsigma_{it}\sigma^2_{iyt-p} + u3_i + e3_{it} \quad (9)$$

$$\sigma^2_{yit} = \alpha_{40} + \sum_{p=1}^{T} \psi_{it}\pi_{i,t-p} + \sum_{p=1}^{T} \Phi_{it}y_{i,t-p} + \sum_{p=1}^{T} \Omega_{it}\sigma^2_{i\pi t-p} + \sum_{p=1}^{T} \varsigma_{it}\sigma^2_{iyt-p} + u4_i + e4_{it} \quad (10)$$

where σ^2_{yit} and $\sigma^2_{\pi it}$ are the uncertainty of output and inflation respectively

Abrigo and Love (2016) provide a Generalized Method Moment (GMM) framework for estimating the PVAR model. In modeling PVAR, there are some issues related to the construction of the data. First, some GMMs have been developed to measure consistent estimation. Anderson and Hsiao (1982) is the early proposal of the estimation technique, although there are some problems related to the first difference (stationary data) that strengthen the gap in unbalanced panels. Arellano and Bover (1995) advocated an orthogonal deviation for the transformation instead of the first difference transformation to minimize the information about missing data. The second problem is the precondition of the estimated data, namely stationarity. Blundell and Bond (1998) suggested that GMM estimators in a univariate estimation have weak instruments in the presence of a unit root.

The appropriate lag order in both the panel VAR specification and the moment condition is required for panel VAR analysis. Based on Hansen's (1982) J statistic of overidentifying limitations, Andrews and Lu (2001) introduced MMSC for GMM models. When we apply Andrews and Lu's (2001) MMSC to the GMM estimator in (2), we get the pair of vectors (p, q) that minimizes:

$$MMSC_{BIC,n(k,p,q)} = J_n(k^2p, k^2q) - (|q| - |p|)k^2 ln\, n \quad (11)$$

$$MMSC_{AIC,n(k,p,q)} = J_n(k^2p, k^2q) - 2k^2(|q| - |p|) \quad (12)$$

$$MMSC_{HQIC,n(k,p,q)} = J_n(k^2p, k^2q) - Rk^2(|q| - |p|)ln\ ln\ n \quad R > 2 \tag{13}$$

where J_n (k,p,q) is the J statistic of overidentifying restriction for a k-variate panel VAR of order p and moment conditions based on q lags of the dependent variables with sample size n and J_n (k,p,q) is the J statistic of overidentifying restriction for a k-variate panel VAR of order p and moment conditions based on q lags of the dependent variables with sample size n.

IV. RESULTS AND DISCUSSION

A. Estimation Results

We begin the analysis with a unit root test for four variables. There are some panel unit root tests in the literature such as Levin *et al*. (2002), Harris-Tzavalis (1999), Breitung (2000), Breitung and Das (2005), Im *et al*. (2003) and Fisher-type (Choi, 2001). In this paper, I use the Levin-Lin-Chu (LLC) test because the data structure has larger time periods (T = 242) than the panels (N = 5). The LLC method is recommended by LLC (2002). In this case, T grows faster than N and N/T approaches 0. Another assumption I used in the LLC test is that the 5 ASEAN countries included tend to have similar economic structure. The results show that the variable π is stationary at the 5 percent level with a p-value of 0.0392 and the variable y has significance at the 1 percent level. Both variables are tested in the equation test with no time trend because the movement of the line does not reveal a trend pattern. Appendix (Table A.2) provides a summary of the LLC stationarity test.

In the second step, the mean equation was estimated with AutoRegressive (AR) components by running models (1) and (2) in fixed and random effects models. Appendix, Table A.1 summarizes the estimation results for the two standard panel estimates for, π and y. the number of lags included in the model are selected based on Bayesian Information Criterion (BIC). Output (y) model shows that random effect is more suitable than fixed, in contrary, π is shown to be fixed effect.

The dummy variable for countries is not shown because the fixed effect is not the best model for the analysis. Moreover, this result suggests that the lag coefficients of these two models work in the opposite direction. The significant coefficients of the production model are all negative, while the coefficients of the inflation mean model are all positive. However, this is consistent with Bhar and Mallik (2012) who also showed in their study that the sum of the coefficients of output and inflation are in the opposite direction, i.e., the output coefficients are negative, and the inflation coefficients are instead positive. In the context of separate time series approach, some results are different in estimating the mean equation of inflation and its uncertainty in ASEAN countries (Mohd, *et al*., 2013, and Jiranyakul and Opiela, 2010)

Post estimation tests (heterogeneity, serial correlation, and cross-sectional dependence) of the fixed and random effects reveal groupwise heterogeneity and cross-sectional dependence for the π fixed model and cross-sectional dependence for the y model (Table A.3). I apply the modified Wald statistic proposed by Baum (2000) for groupwise heterogeneity, the bias-corrected statistic developed by Born and Breitung (2016) for the test of serial correlation, and the test of cross-sectional dependence developed by Frees (1995, 2004). I found the solution to the problems presented by using a panel data regression with corrected standard error, basically estimated using either Ordinary Least Square (OLS) or Prais-Winsten regression as proposed by Beck and Katz (1995). Using the most appropriate model in Appendix, Table A.1, I measured the variance and the square of the residuals to take the ARCH, GARCH, asymmetric effect as shown in Equation (5). This is the standard model for Exponential GARCH using the maximum likelihood function in Equation (4) to optimize the value of the likelihood of the conditional variance and all parameters in the variance equation. Moreover, the estimated parameters of the variance are positive and highly significant at the 1 percent level (Table A.4). I take the predicted value of the variance equation and set it as an exponential value, as a measure of uncertainty in both growth and inflation, from the best-fitting model of the conditional variance equation. The LLC test, reported in Appendix, Table A.2, shows that both uncertainty variables are stationary.

Moreover, the standard estimate of the PVAR model. Instead of other criteria for selecting the optimal delay (Table A.5), this paper focuses on the Hansen's J statistic. Moreover, based on the selection process, a fourth-order model that has the lowest MAIC and accepts the Hansen overidentification constraint at a level of 1 to 10 percent is preferred. Thus, there is no possibility of missing specification of the model. However, the coefficients of the estimates VAR may not be examined as the causal effects, instead the Impulse Response Function (IRF) is known as the interpretation of the stable panel VAR. Moreover, the stability test (Figure A.1 and Table A.6) shows that the modulus is less than zero, it is between 0.21 and 0.95, so the model is stable and the analytical process on the impulse response function can be continued.

B. Empirical Findings and Discussion

According to the IRF (Figure A.2), there is negative effect of output uncertainty (σ^2_{yit}) on output growth (y). These results are consistent with the argument that producers always try to estimate their return on investment, so that the higher the uncertainty about growth, the riskier the investment projects, and hence the higher the demand for investment and the output produced. Some studies come to similar conclusions, Antonakakis and Badinger (2012), and the theoretical argument of Bernanke (1983), Pyndick (1991) that the negative effect of output uncertainty on output comes from the negative response of investment at the firm level. In addition, Ramey and Ramey (1991) show that higher uncertainty reduces the optimality of firm production due to the uncertainty generated, which leads to bad decisions by firms and then causes lower growth. On the other hand, the effect of growth-on-growth uncertainty is simultaneously positive, implying that higher growth can worsen stability. This is like the work of Lin and Kim (2013) who use Simultaneous Equation Model (SEM) to consider the endogenous behaviour of growth and growth uncertainty.

As for the inflation variable, the relationship between inflation and inflation uncertainty is similar to that between growth and growth uncertainty. Inflation uncertainty has a negative effect on the inflation rate, which is referred to as Holland

Hypothesis or Stabilizing Fed Hypothesis. This result is confirmed by Grier and Perry (1998), Daal *et al*. (2005), Thorton (2007) and Chang (2012). The idea originated from Holland (1995) who suggested that when uncertainty is higher, the central bank will adopt contractionary monetary policy to lower inflation. The backward effect that inflation positively affects inflation uncertainty supports Friedman-Ball Hypothesis. When inflation rises, economic agents face uncertainty about future prices. In other words, economic agents cannot clearly see what policy makers will do in this situation. In such a situation, inflation uncertainty increases with the uncertainty of money supply and future inflation. Some empirical evidence shows similar results as Hartmann and Herwartz (2012), Balcilar *et al.* (2011). The same bidirectional case of inflation and inflation uncertainty is also presented by Jiranyakul and Opiela (2010).

Lin and Kim (2013) show that there is a negative effect of growth volatility on growth, suggesting a stabilisation policy to mitigate short-run fluctuation, and a positive effect of growth-on-growth volatility/uncertainty, suggesting that there is a feedback effect indicating that growth at a certain level can generate volatility. Another argument why it is likely that the effects of growth and growth volatility/uncertainty cancel each other out is the existence of a nonlinear relationship between growth and growth uncertainty. Chowdhury *et al*. (2020) point out that the assumption of linearity cannot be sustained in a large sample because macroeconomic policies and the macroeconomic system can undergo significant changes. Ludvigson *et al*. (2018) support the arguments that macroeconomic uncertainty in the recession period may be endogenous in response to growth shocks. These arguments are consistent with inflation and inflation uncertainty, where they exhibit a nonlinear relationship, as confirmed by Chen *et al*. (2015). Thus, this is the motivation of stabilisation policy, because growth uncertainty worsens growth, and growth increases growth uncertainty. Moreover, inflation uncertainty reduces inflation, which may be caused by the inflation stabilisation policy of the central bank and the government, while high inflation rate may in turn lead to high inflation uncertainty.

The interaction between inflation and growth can also be seen. Inflation has a negative impact on ASEAN-5 growth, but the growth shock does not contribute to inflation, according to the IRF. This is a standard framework for the short-run Phillips curve, i.e. when growth reaches its steady-state level, it would lead to inflationary prices. Theoretically, there is a possibility that the effect may have the opposite effect, namely that output growth may cause higher inflation (Briault, 1995).

V. CONCLUSION

The objective of this study is to examine the interrelationship between inflation, inflation uncertainty, growth and growth uncertainty. This study uses monthly data provided by Global Economic Monitoring (GEM) from the World Bank for the period 2000-2020, comprising a total of 1210 observations. The contribution of this paper is to provide a panel data analysis for the interrelationships among these four variables in the panel VAR. Existing studies investigating these interrelationships do not use PVAR as a method to deal with the endogeneity problem between variables and generalize to such typical regions as ASEAN, Euro, emerging economies or even G7 countries and most use single country analysis. The second contribution of this paper is to find a measure of uncertainty. I use Exponential GARCH in the panel data model to generate the conditional variance as a measure of uncertainty, rather than the restricted panel GARCH.

The results suggest that there is a bidirectional interaction between output and output uncertainty. There is a negative effect of output uncertainty on output growth, which supports some previous studies, Antonakakis and Badinger (2012), and the theoretical arguments of Bernanke (1983), Pyndick (1991), and Ramey and Ramey (1991). However, the effect of growth-on-growth uncertainty is positive, suggesting that higher growth could increase instability, which is referred to as the feedback effect. This result is consistent with that of Lin and Kim (2013) who apply a structural model to account for the endogeneity problem between growth and growth uncertainty and find that there is a bidirectional and. As for inflation and inflation uncertainty, these two variables are also interrelated. This study supports Holland Hypothesis or stabilizing Fed Hypothesis in which inflation uncertainty negatively affects inflation and on the other hand inflation positively determines inflation uncertainty which supports Friedman-Ball hypothesis. This bidirectional relationship supports Jiranyakul and Opiela (2010). The cross-variable inflation and growth shows that inflation has a negative impact on growth as shown in the standard Phillips curve model. As a policy implication of these findings, fiscal and monetary policy authorities should keep the trend of growth and inflation at moderate levels to achieve the desired impact on the economy.

The improvement for the next study can be related to the development of the GARCH family to measure the uncertainty in the panel data set. The simulation of other forms of the GARCH model instead of the standard panel GARCH developed by Cermeno and Grier (2001) needs to be considered. In addition, it may be interesting to model monetary policy instrument variables in the panel VAR to examine the response of policy shocks to uncertainty, growth, and inflation, and implementing nonlinear panel VAR may provide a more sophisticated picture.

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APPENDIX

Figure A.1
Stability Test Graph

The Graph shows the stability picture of Panel VAR model. Dots inside the outside bold-lined circle depicts imaginary and real meaning that if all dots are inside the outer circle, the Panel VAR model is stable.

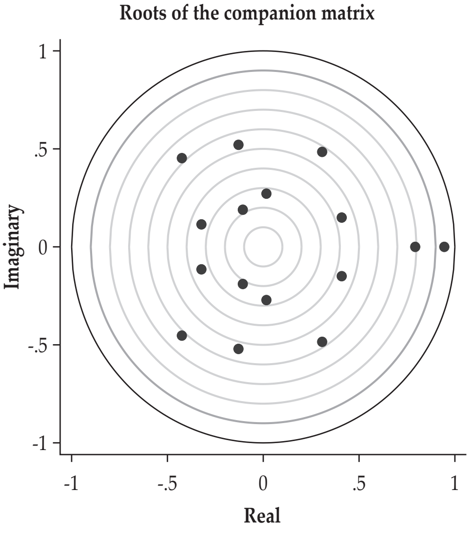


Figure A.2
Impulse Response Function

The IRF confidence intervals were calculated using 200 Monte Carlo draws from the fitted reduced-form panel VAR model's distribution. The IRF suggests that the graph which does not include zero line shows significant effect the variable shocks.

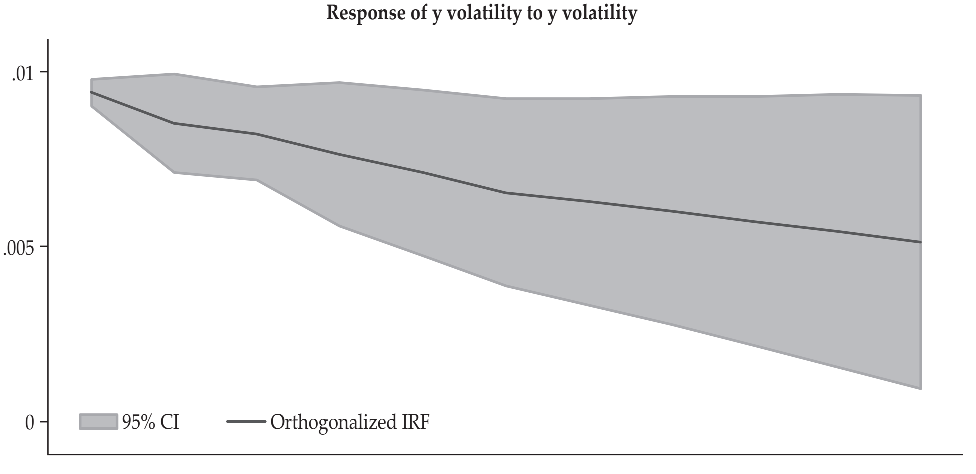


Figure A.2
Impulse Response Function (Continued)

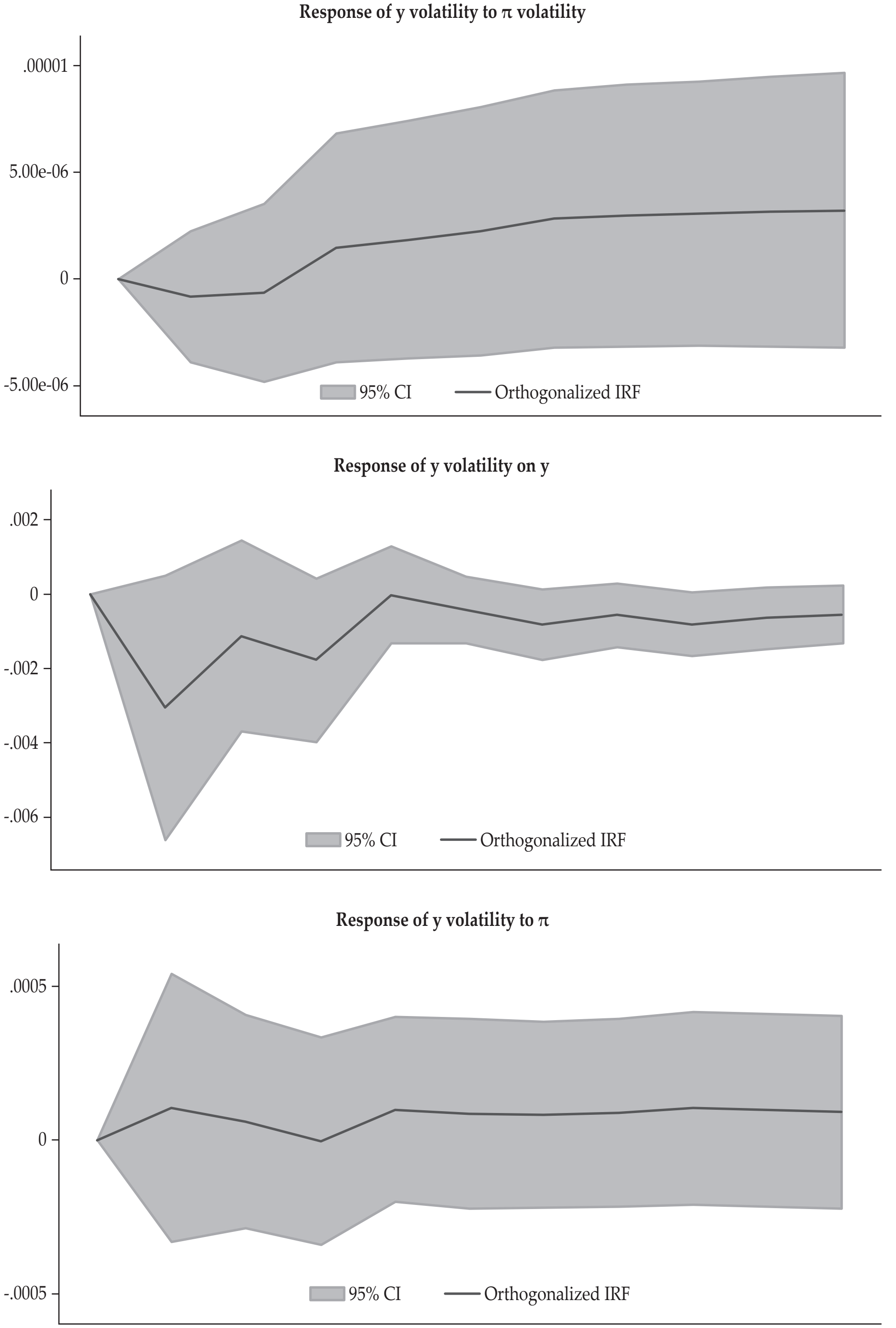
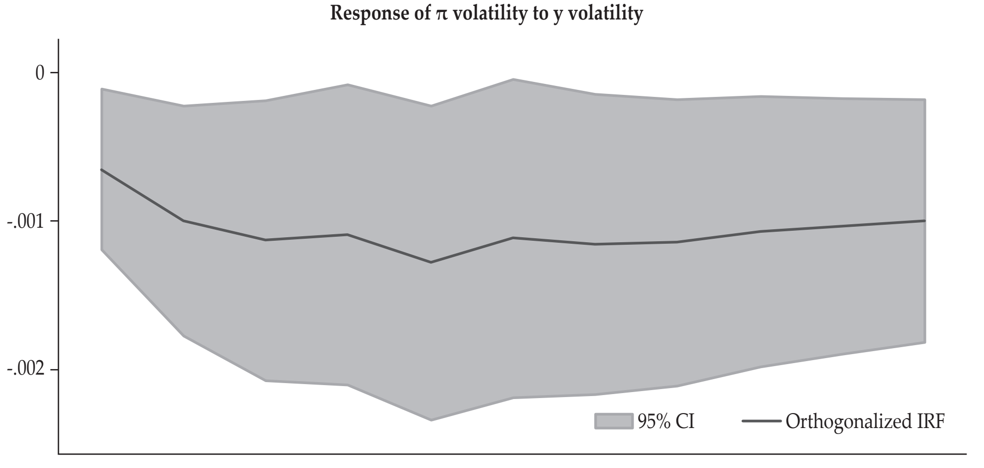
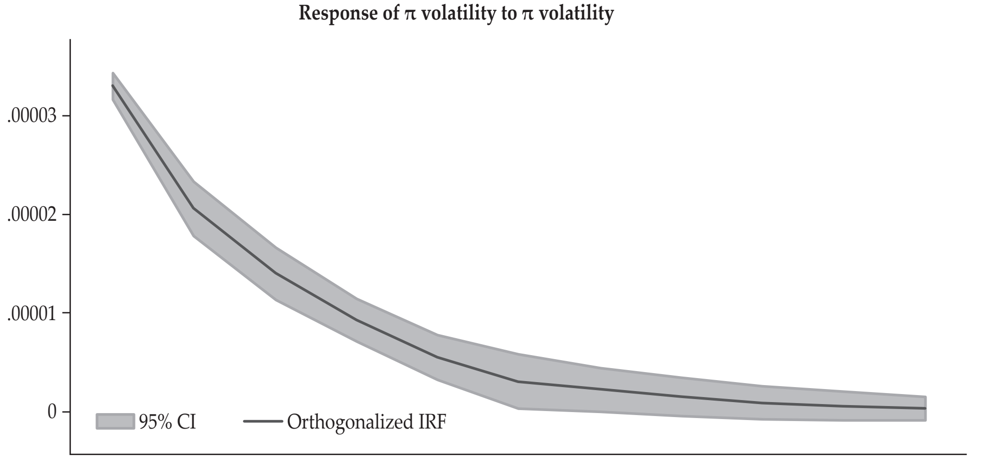


Figure A.2
Impulse Response Function (Continued)





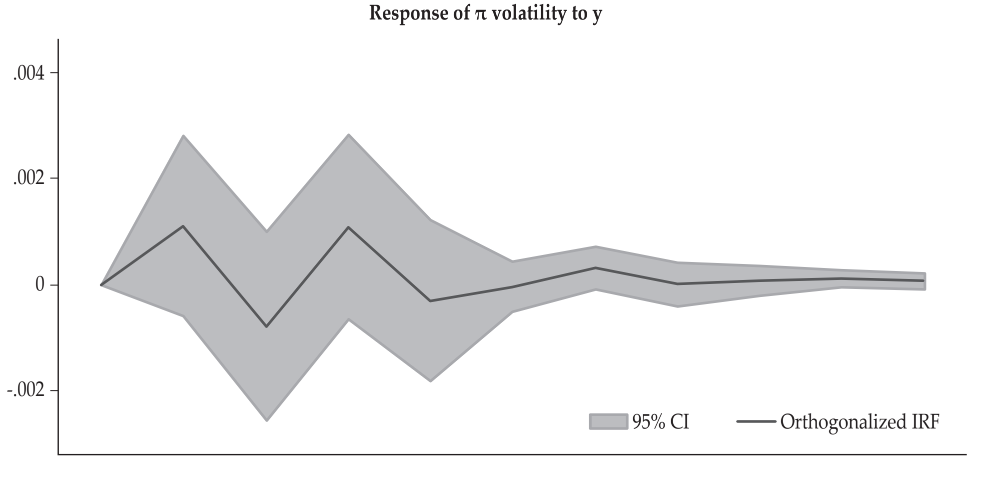


Figure A.2
Impulse Response Function (Continued)

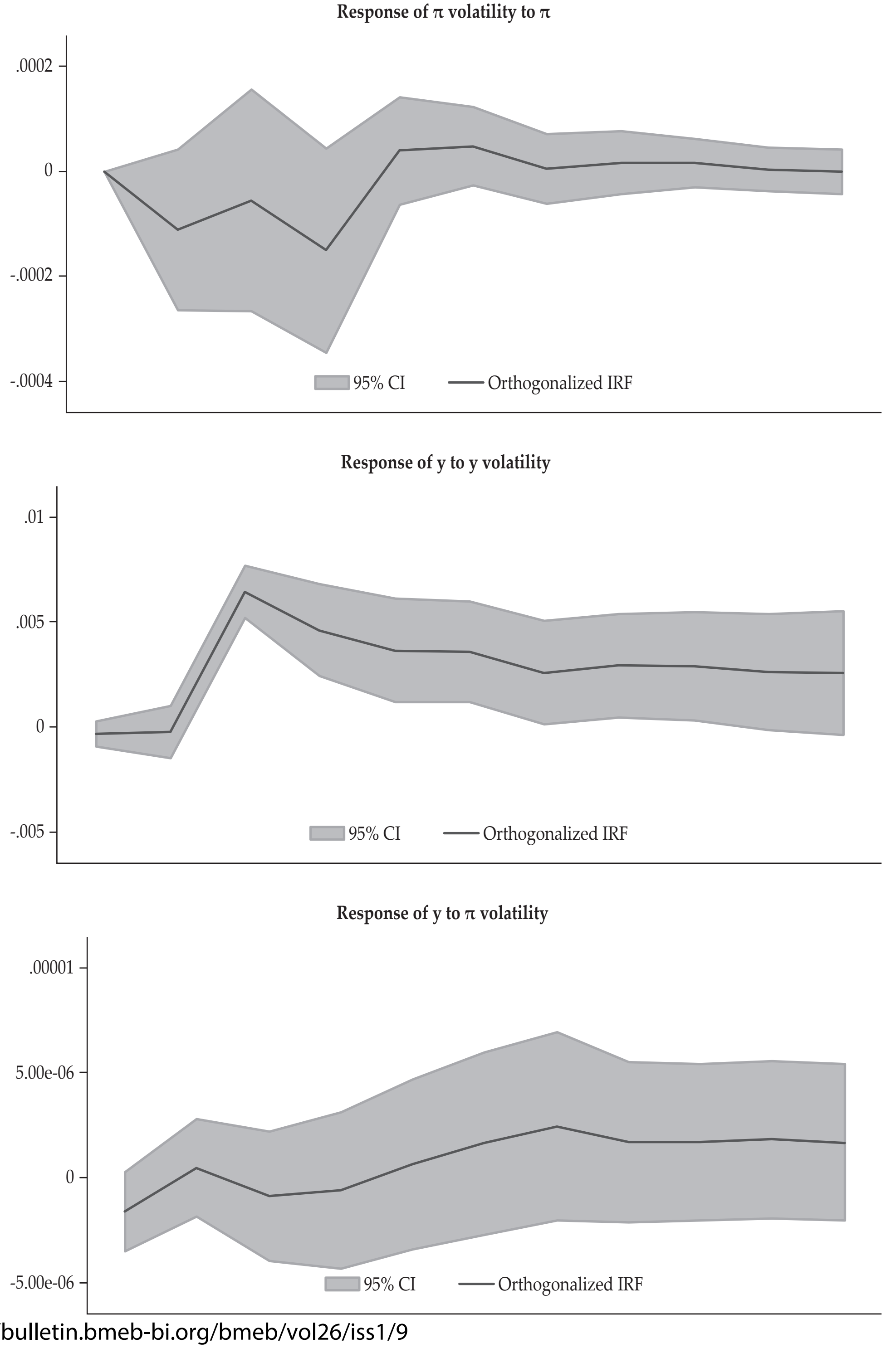


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Figure A.2
Impulse Response Function (Continued)

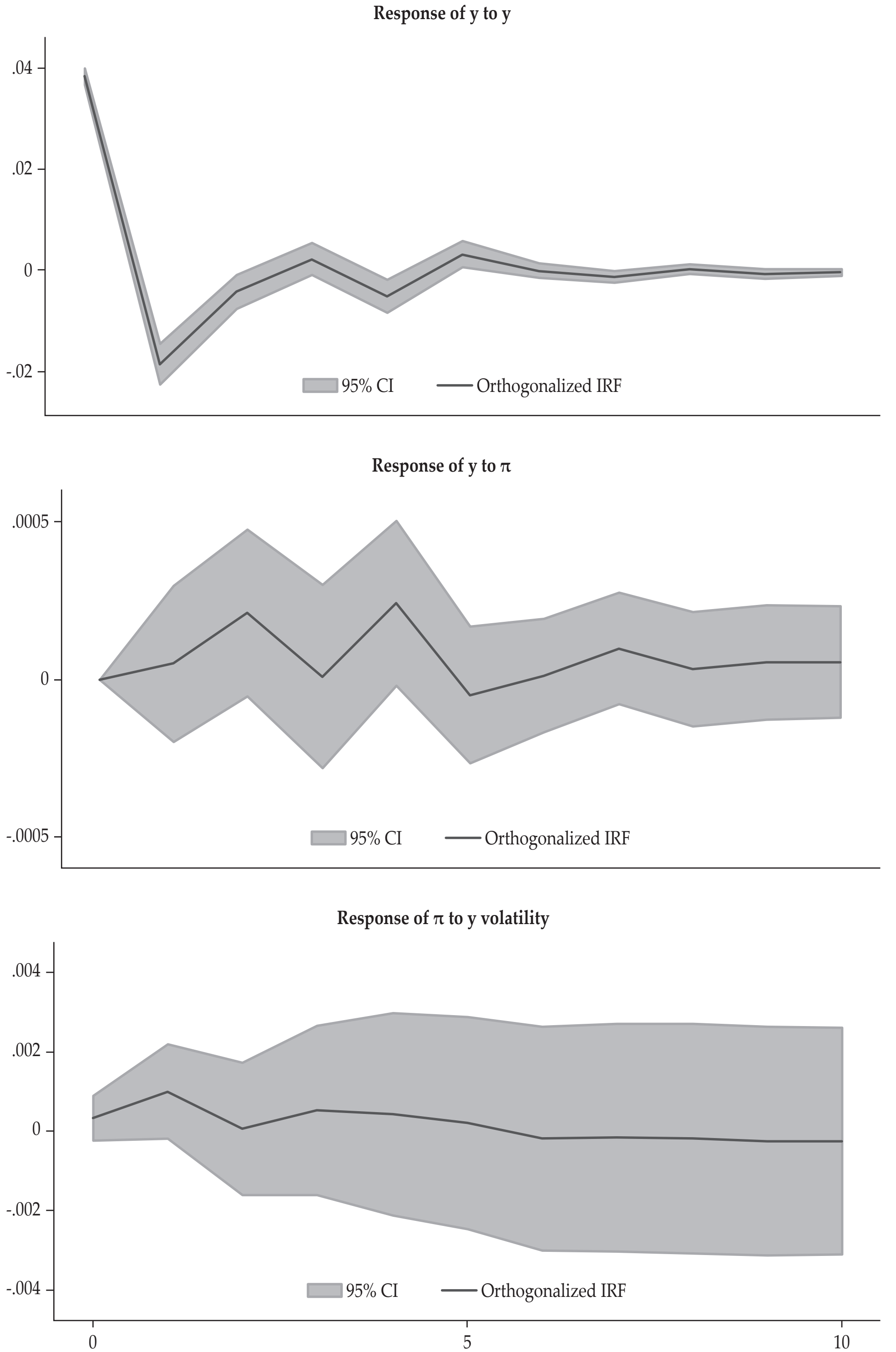

Figure A.2
Impulse Response Function (Continued)

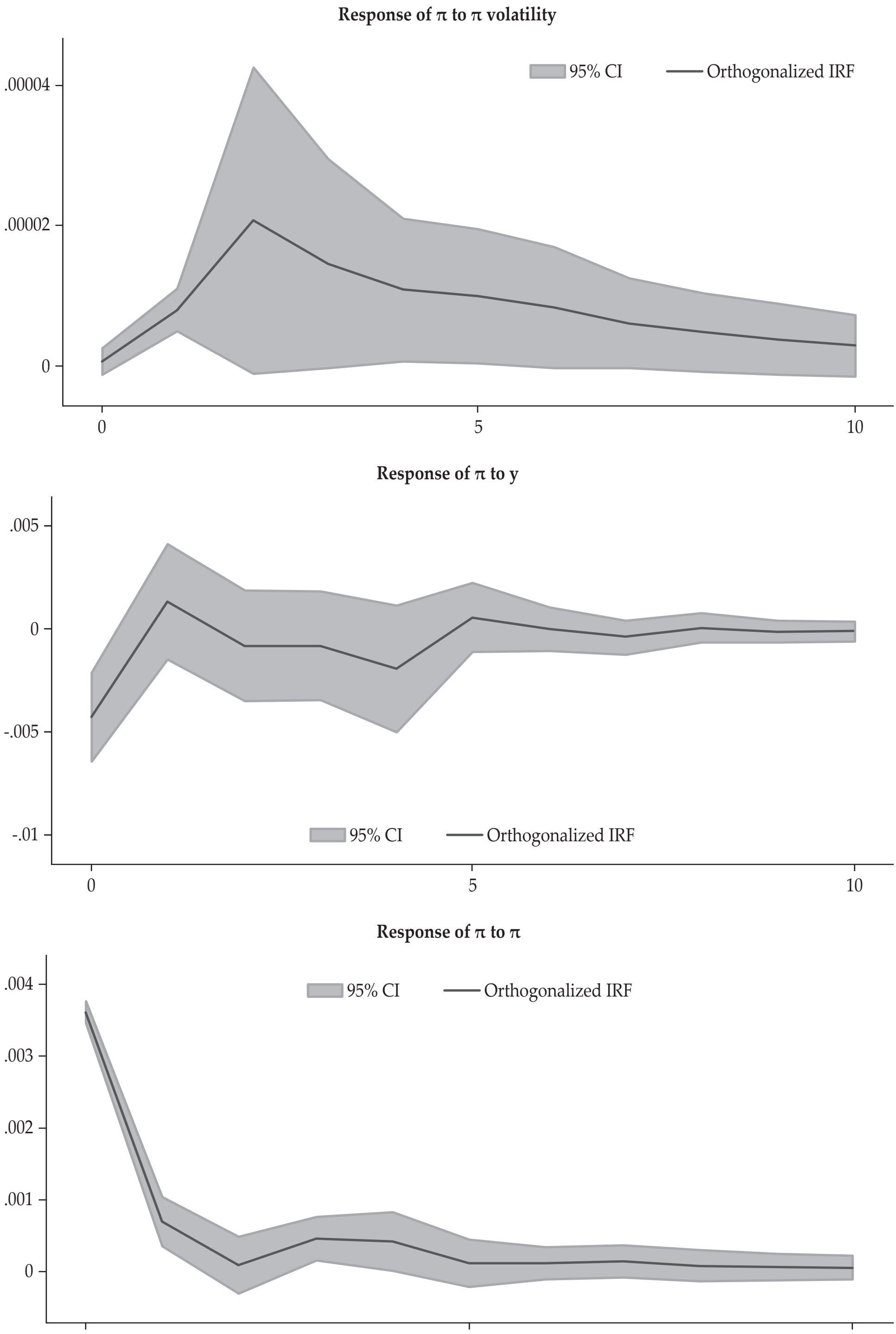

Table A.1.
Mean Equation with AR Components

Appendix A.1 summarizes mean model estimation results. Using three model specifications, Fixed Effect, Random Effect, and Panel Corrected Standard Error. For comparison. Table A.1 provides those three estimation and selection the best model is based on Hausman test for Fixed and Random, and some post-test summarized on A.3 to select the model. Model AR(8) is used to estimate mean model based on Bayesian Information Criteria (BIC) since most models results in smallest BIC at AR(8). Lee (2008) use apriori model to select lag length criteria with AR(12). *10 Percent, ** 5 Percent, *** 1 Percent.

Variable	**Output (y) Model**			**Variable**	**Inflation (π) Model**		
	Fixed Effects	**Random Effects**	**Panel Corrected Standard Error**		**Fixed Effects**	**Random Effects**	**Panel Corrected Standard Error**
	Coefficient (Standard Error)	**Coefficient (Standard Error)**	**Coefficient (Standard Error)**		**Coefficient (Standard Error)**	**Coefficient (Standard Error)**	**Coefficient (Standard Error)**
yt-1	-0.39990***	-0.39905***	-0.39905***	πt-1	0.22671***	0.25186***	0.25186***
	(0.02951)	(0.02945)	(0.03381)		(0.02944)	(0.02940)	(0.03507)
yt-2	-0.23483***	-0.23366***	-0.23366***	πt-2	-0.00334	0.01908	0.01908
	(0.03180)	(0.03173)	(0.03618)		(0.03002)	(0.03007)	(0.03625)
yt-3	-0.07122**	-0.06988**	-0.06988*	πt-3	0.09658***	0.11982***	0.11982***
	(0.03252)	(0.03244)	(0.03680)		(0.03003)	(0.03006)	(0.03624)
yt-4	-0.17212***	-0.17071***	-0.17071***	πt-4	0.03778	0.05820*	0.05820
	(0.03255)	(0.03247)	(0.03681)		(0.03014)	(0.03023)	(0.03641)
yt-5	-0.06604**	-0.06463**	-0.06463*	πt-5	-0.02441	-0.00351	-0.00351
	(0.03244)	(0.03236)	(0.03670)		(0.03011)	(0.03019)	(0.03636)
yt-6	-0.03136	-0.02990	-0.02990	πt-6	0.02313	0.04703	0.04703
	(0.03242)	(0.03233)	(0.03667)		(0.02993)	(0.02994)	(0.03609)
yt-7	-0.07402**	-0.07273**	-0.07273**	πt-7	0.10423***	0.12710***	0.12710***
	(0.03175)	(0.03167)	(0.03605)		(0.02987)	(0.02990)	(0.03603)
yt-8	-0.02063	-0.01969	-0.01969	πt-8	-0.02404	0.00172	0.00172
	(0.02934)	(0.02928)	(0.03342)		(0.02902)	(0.02894)	(0.03429)
constant	9.53871***	9.49327***	9.49327***		2.59577***	1.74497***	1.74497***
	(0.63291)	(0.63008)	(0.69580)		(0.26961)	(0.22212)	(0.27008)
R-sqr	0.167		0.167	*R*-sqr	0.084		0.156
dfres	1152		1152	dfres	1152		.
BIC	-3891.2	.		BIC	-9380.0		
Hausman Test	Chi=0,58			Hausman Test	Chi Square =31		

Table A.2.
Levin-Lin-Chu Panel Stationary Test

This table shows the results of Levin-Lin-Chu Panel Stationary test for y, π, σ_π^2 , and σ_y^2 which shows that all variables included in the models are stationary at level since the P-Values are less than 0.05. as consequence, the estimation model is estimated using level variables.

Variable	Unadjusted Statistics	Adjusted Statistics	*P* - value
y	-243.628	-86.496	0
π	-134.731	-17.603	0.039
σ_π^2	-158.596	-136.762	0
σ_y^2	-70.118	-55.984	0

Table A.3.
Panel Post Test of Mean Model Estimation

The table shows the mean model results. Row 1 provides Bias Corrected Born and Breitung test for autocorrelation and the results show that there is no evidence that autocorrelation exists since all P value are less than 0.05. Row 2 shows summary of Frees Cross sectional dependence develop by Frees (1995) which shows there is significant at alpha 1 percent meaning rejection of null hypothesis of cross-sectional independence. Row 3 summarizes groupwise heterogeneity test for fixed effect models showing that there is rejection null hypothesis of homogeneity. Row 4 shows the results of Breusch Pagan LM test for Random Effect to decide between random effect regression or simple Ordinary Least Square finding that the probabilities of those two random effect models of growth and inflation equation are not significant meaning that random effect model is not appropriate.

No	Panel Estimation Post Test	Fixed Effect Model of Growth (y)	Random Effect Model of Growth	Fixed Effect Model of Inflation (π)	Random Effect Model of Inflation
1	Bias Corrected Born and Breitung for Autocorrelation	*P*-value = 0.975	*P*-value = 0.982	*P*-value = 0.829	*P*-value = 0.722
2	Frees Cross Sectional Dependence (De Hoyos and Sarafidis, 2006)	0.06***	0.061***	0.120***	0.103***
3	Groupwise Heterogeneity Test	Chi = 4058.97 Prob = 000		Chi =3.3×10^5 Prob = 000	
4	Breusch Pagan LM Test for Random Effect		Prob = 1		Prob = 1

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Table A.4.
Variance Equation

The table reports variance equation estimation of Panel Exponential GARCH Model of inflation and growth. The Shows that all coefficients are significant and have positive signs. The dependent variables are conditional variance inflation and output growth which are taken from the best estimation results of mean equation reported in A.1. Standard error in parentheses, and *, **, *** denotes statistical significance of 10 Percent, 5 Percent, 1 Percent.

Variance Equation			
Inflation (π)		Output (y)	
Variable	Coefficient (Standard Error)	Variable	Coefficient (Standard Error)
β_π	0.69544***	β_y	0.96930***
	(-0.02087)		(-0.00689)
α_π	0.00000000692***	α_y	0.000082***
	(0)		(0)
θ_π	0.0000933***	θ_y	0.00093***
	(0)		(-0.00025)
Constant	-0.00001*		0.00476**
	(0)		(-0.00203)

Table A.5.
Lag Selection Criteria

The table A.5 is the order selection from the first to the fourth order panel VAR models using the four lags of endogenous variables. Models using the first four lags of the endogenous variables. According to three model selection criteria by Andrews and Lu (2001), the fourth-order panel VAR is the selected model because this has the smallest MAIC while I also want to minimize Hansen's *J* statistic. The first and second order panel VAR models reject Hansen's overidentification restriction at the 5% alpha level, meaning possible misspecification in the model; thus, it should not be selected.

Lag	CD	*J*	*J P*-value	MBIC	MAIC	MQIC
1	0.989	165.623	0.0000021	-465.871	-14.376	-185.0673
2	0.996	118.542	0.000458	-386.653	-25.457	-162.010
3	0.995	64.364	0.294	-349.615	-53.635	-165.533
4	0.986	19.913	0.997	-267.767	-62.086	-139.8451

Table A.6.
Stability Test Table

The table summarizes the values of real and imaginary as well as modulus value as depicted in A.6.

Eigen Value		Modulus
Real	**Imaginary**	
0.944	0	0.944
0.792	0	0.792
-0.424	0.452	0.620
-0.424	-0.452	0.620
0.307	0.484	0.573
0.307	-0.484	0.573
-0.129	-0.520	0.536
-0.129	0.520	0.536
0.409	-0.149	0.435
0.409	0.149	0.435
-0.322	0.114	0.342
-0.322	-0.114	0.342
0.016	-0.271	0.272
0.016	0.271	0.272
-0.106	0.189	0.217
-0.106	-0.189	0.217

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