EXAMINING THE DYNAMIC RELATIONSHIP BETWEEN MONEY SUPPLY GROWTH AND MACROECONOMIC STABILITY IN AUSTRALIA: EVIDENCE FROM A VAR MODEL

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ABSTRACT — This paper analyses the relationship between Australia's money supply growth, inflation and unemployment in a dynamic way from 2000-2024. The paper, which is based on annual time-series data in the World Bank's World Development Indicators, applies a Vector Autoregression (VAR) model to analyze the interrelationship between these macroeconomic variables. The presence of mixed orders of integration is uncovered by a series of unit root tests, but the VAR model is estimated in levels to examine the short-run dynamics. Empirical data has shown that there is high persistence in both inflation and unemployment. However, the short-run impact of the rise in money supply on both inflation and unemployment rates in the estimated VAR system is not statistically significant. Also, the stability test confirms that the estimated VAR model is stable. When exogenous dummies controlling for the effects of the Global Financial Crisis and COVID-19 structural shocks chave been included, inflation is found to Granger-cause unemployment in the short run, which is in line with the Phillips curve framework. The results provide empirical evidence on the dynamics of a developed inflation targeting economy and are potentially relevant to emerging economies where the institutional framework of monetary transmission mechanisms is less developed. This research has several limitations, such as using annual data, having a relatively small size sample, and excluding variables like interest rates, output growth, etc.

Keywords— Inflation, Unemployment, Broad money growth, VAR model, Granger causality, Australia

I. INTRODUCTION

The economic policy in both developed and emerging economies is focused on achieving macroeconomic stability. Of the key indicators that are employed to measure economic stability, inflation, unemployment, and money supply growth are of special importance since they demonstrate the dynamics of prices, labor market, and monetary policy position. It is important to understand the interrelation between these macroeconomic variables hence to the policymaker who aims to ensure prices are kept stable and the economy keeps growing sustainably [1], [2]. The Australian case is a good country in which to study these macroeconomic correlations. Being a developed economy with an inflation-targeting regime in place, the Reserve Bank of Australia (RBA) is focused on keeping inflation within the target range of 2 to 3 percent over the medium term and supporting the growth of the economy and employment. With the World Bank noting that over the past 20 years, economic performance in Australia has been relatively stable, the country had an average of 2.8 per cent growth in real GDP annually between 2000 and 2019 [3]. Nonetheless, the macroeconomic conditions transformed greatly after the COVID-19 pandemic. The inflation increased sharply in the year 2022 to about 6.6 percent and subsequently decreased slowly in the following years, whereas unemployment decreased to around 3.7 percent in 2023, one of the lowest in several decades [4]. These evolutions underscore the dynamism in terms of macroeconomic interactions and the significance of the interactions between inflation, unemployment, and money supply in each other over time.

While the macroeconomic theories, containing the quantity theory of money and the Phillips curve, have been able to explain the relationship between inflation, unemployment and the amount of money in circulation, empirical research has shown that the relationships between these tend to vary in different economic conditions. There can be structural changes, financial crises and policy modifications that can change the dynamics between these variables dramatically. For example, parallel movements in inflation and the state of the labor market and monetary policy's response to these large economic shocks, such as the global financial crisis and COVID-19 pandemic, are apparent [5, 6]. The empirical evidence provided is typically of the relationship between inflation and money supply, or the relationship between inflation and unemployment. However, relatively few studies incorporate all three variables in a single dynamic model. For the Australian economy specifically, VAR-based studies covering the post-2000 period that include money supply growth alongside inflation and unemployment remain scarce, particularly those accounting for structural shifts introduced by the GFC and COVID-19. The above-mentioned gap in the literature has prompted the current research to explore the dynamic relationship between inflation, unemployment and money supply growth in Australia between 2000 and 2024. In particular, the research questions that are covered by the study are as follows: (1) What is the dynamic relationship between inflation, unemployment, and money supply growth in Australia? (2) Do any of these variables have short-run Granger causes for the others? To answer these questions, the research adopts a Vector Autoregression (VAR) model using annual time-series data from World Development Indicators (WDI) database of the World Bank.

This research has a number of contributions to the literature. Firstly, it provides the latest, empirical evidence on the dynamic relationship between inflation, unemployment and money supply growth in Australia from 2000 to 2024, including the post-pandemic adjustment phase. Second, it is feasible to study the feedback relationships between macroeconomic variables using a VAR framework, although without any pre-specified causal assumptions. Third, while the analysis focuses on Australia, the findings offer relevant insights for emerging economies where monetary transmission mechanisms and macroeconomic stabilization remain active policy priorities.

II. LITERATURE REVIEW

A. UNEMPLOYMENT, INFLATION AND MONEY SUPPLY AS ITS THEORETICAL BASIS,

The relationships which have been focal issues in the macroeconomic theory are inflation, unemployment, money supply. The oldest theories which attempt to explain the nature of inflation are the Quantity Theory of Money which assumes that overall level of prices is directly proportional to quantity of money available in the economy. The equation MV = PY (where M is money supply, V is the velocity of money, P is the price level, and Y is real output). If the velocity of money and the output change are relatively stable, then the more money supplied, the more inflation will be created, and the more output produced [7, 8, 9]. This philosophy has been a key component of the modern policy frameworks of monetary policy, particularly in the countries that use inflation targeting. Such a theoretical hypothesis suggests that the growth of broad money should be positively correlated with inflation and that this relationship may be time-lagged since there is a transmission lag between money growth and inflation, which is associated with the mechanism of monetary transmission through the banking sector and credit channels.

Another significant set of theory is the Phillips curve; this set of theory explains the connection between inflation and unemployment. The initial Phillips curve postulated an inverted connection between inflation and unemployment and therefore expansionary economic policy has the possibility of decreasing unemployment but an increase in inflation (Phillips, 1958). This framework was then elaborated later by situations that added expectations, resulting in the expectations-augmented Phillips curve that Friedman (1995) and Phelps (1967) developed. The argument in these models is that the existence of a short-run trade-off between inflation and unemployment is probable but the relationship deteriorates in the long-run as the economic agents change their future inflation expectations. The recent changes in macroeconomic theory have put a greater focus on the aspects of expectations, globalization and credibility of the monetary policy in determining the relationship between inflation and the dynamics. In the current example, the contemporary New Keynesian models indicate that inflation is established based on the expectations of the future, economic slack, and the credibility of the policy [11], [12]. This means that the relations between the variables of inflation, unemployment and money have been more complicated especially when world economic shocks and structural changes are involved. The implication for empirical modeling is that lagged inflation should positively predict current inflation, while unemployment shocks are expected to carry persistent effects given the slow adjustment of labor markets. Together, these theoretical frameworks suggest that in a VAR model, inflation and unemployment should exhibit strong autoregressive behavior, while the effect of money supply shocks on inflation may be attenuated in credible inflation-targeting regimes.

B. EMPIRICAL EVIDENCE ON INFLATION, UNEMPLOYMENT, AND MONEY SUPPLY

There is a substantial amount of empirical literature which has studied the relation between money supply and inflation. Previous studies across the USA suggested significant backing of the long-run link associated with the Quantity Theory of Money and the high inflation rates, where the long-run growth path of the money supply was well linked with the high level of inflation [13]. However, the strength of this link seems to fluctuate over time and across countries as a result of the changes in monetary policy models and financial market organizations [14]. Makin, Robson and Ratnasiri (2017) investigated the relationship between excess money growth and CPI inflation in Australia between 1970 and 2015, and they determined that the relationship between the two has been strong historically, but not as strong since the RBA began targeting inflation in early 1990s. This finding holds direct relevance for the present study's sample period (2000–2024) as it is entirely post-inflation targeting and may display a weakened money–inflation transmission.

Besides the financial explanation of inflation, numerous empirical investigations have also been done on the relationship between inflation and unemployment with the Phillips curve model. While the first research papers were positive on the existence of a stable trade-off between the two variables, there is some more recent research that suggests the relationship has decreased in most developed economies [15]. To illustrate this, the recent research on the New Keynesian Phillips curve shows that the correlation between inflation and unemployment has been flatter since the 1980s because of such factors as globalization, the enhanced credibility of monetary policy and anchored inflation expectations [16]. Kuttner and Robinson (2010) estimated the hybrid New

Keynesian Phillips curve for Australia and determined that the coefficient on expected inflation is higher than that on lagged inflation, but the labor market slack variable is not significant, indicating that expectations of inflation are the main determinant of Australian inflation. This suggests that the direct Granger-causal relationship between unemployment and inflation could be rather weak in a short-run VAR setup. Recent empirical evidence also suggests that macroeconomic shocks have an impact on the inflation process and on labour market mechanisms. As an example, the COVID-19 pandemic induced enormous variations in the rate of inflation and unemployment rate in most economies [2], [15]. Research suggests that inflation expectations changes can potentially significantly affect the inflation and employment dynamics, the wage dynamics, and investment decisions and consumption behavior [12, 17]. These results show that inflation, unemployment and monetary relationships are affected by different factors and can be different in the economic conditions and time.

C. VAR APPROACHES IN MACROECONOMIC ANALYSIS

In an effort to comprehend the dynamic relations between the macroeconomic variables, it is upon many researchers to use multivariate econometric models like the Vector Autoregression (VAR) model. The originally developed VAR model by [18] enables each variable in the system to be considered endogenous and affected by its own past values and those of other variables. The method avoids the strict theoretical constraints that macroeconomic models impose on researchers to examine complex feedback relationships between macroeconomic indicators.

In macroeconomic studies, VAR models have been popular in studying the transmission of monetary policies, inflation, as well as business cycles. The recent literature has used VAR and other related models to analyse the relationship between inflation, unemployment, and monetary variables in various economic situations [6], [19]. Dungey and Pagan (2000) developed an 11-variable structural VAR for the Australian economy over 1980–1998, establishing a benchmark for VAR-based macroeconomic analysis in Australia that subsequent studies have extended. Besides, recent studies have augmented the classic VAR model by including time-varying parameters and expectations so that the researchers can better represent structural changes in macroeconomic relations. These models have gained more significance on the study of effects of monetary policy and inflation expectation in terms of their effects on the economic activity. Despite this growing literature, studies that jointly model inflation, unemployment, and money supply growth for Australia using post-2000 data — encompassing both the GFC and COVID-19 shocks — remain limited. The present study addresses this gap by applying a VAR framework to annual data covering 2000–2024 within a unified three-variable system.

III. METHODOLOGY

A. RESEARCH METHOD

The research method used in the study is quantitative research, where the phenomenon studied is the dynamics between inflation, unemployment and growth of money supply in Australia. Particularly, the analysis will apply the Vector Autoregression (VAR) model that is commonly applied to study the dynamic relationships between multiple time-series variables in the macroeconomic literature. The VAR model considers all the variables in the system endogenous, that is, each variable is determined not only by the previous value of the particular variable but also by the previous value of other system variables. This is a property which makes the VAR framework particularly suitable for analyzing the dynamic interactions and feedback effects between the macroeconomic indicators, without making a priori hypotheses about the causality of the interactions [18], [20]. The results of the unit root test show mixed integration orders where lnINF and lnUR are integrated of order one - I(1) - while lnBMG is stationary at level - I(0). The VAR model is still estimated in levels (as done by Sims, Stock and Watson 1990) and shown to be appropriate for inference on short-run dynamics like Granger causality and impulse response functions, as long as attention is paid to short-run interactions instead of long-run cointegrating relationships. It should be emphasized that the results derived from this framework should be interpreted as short-run exploratory dynamics rather than as strong causal evidence. An alternative robustness check would be the Toda–Yamamoto (1995) causality procedure, which augments the VAR lag order by the maximum integration order to preserve standard asymptotic inference under mixed integration; however, given the already limited effective sample size (n = 22 after lag selection), such augmentation would further reduce degrees of freedom, and this approach is therefore recommended for future work using higher-frequency data. To account for the potential influence of major macroeconomic disruptions on the estimation results, two binary dummy variables are incorporated as exogenous regressors in the VAR model. The first dummy variable (d_GFC) takes the value of one for 2008 and 2009, capturing the period of the Global Financial Crisis, and zero otherwise. The second dummy variable (d_COVID) takes the value of one for 2020, corresponding to the onset of the COVID-19 pandemic, and zero otherwise. Including these dummies as exogenous variables allows the VAR system to control for the extraordinary shocks associated with these episodes without consuming additional endogenous lag structure, thereby improving model fit and residual normality while preserving degrees of freedom. The estimated VAR residuals are then tested for serial correlation (Lagrange Multiplier test), heteroskedasticity (ARCH test), and

normality (Jarque–Bera test) to ensure the completeness of the diagnostic assessment. The analysis covers a few time-series econometric procedures which are commonly used in time-series studies: specification of the VAR model, testing of variable stationarity, optimal lag length estimation, Granger causality test, and stability check of the estimated VAR system to check the reliability of the empirical results.

B. MODEL SPECIFICATION

Three endogenous variables, which represent the major macroeconomic indicators of the Australian economy, i.e., inflation (INF), unemployment (UR), and the growth of broad money supply (BMG), are used in this study as the basis of the VAR model. Inflation is represented by the annual percentage change in consumer price index, unemployment rate is represented by the unemployment rate as a percentage of the total workforce, and the average percentage change in the broad money supply is indicated by the growth rate of broad money supply. All three record positive values over the sample period and so the natural logs are taken directly, thereby avoiding the possibility of heteroskedasticity and stabilizing variance. Transformed variables are now referred to as lnINF, lnUR and lnBMG respectively.

The overall specification of the VAR model allows the specification of each of the variables to depend on its own lagged values as well as the lagged values of other macroeconomic variables in the system, thereby capturing the dynamic interdependence of the macroeconomic variables [20]. In the impulse response analysis, shocks are detected by Cholesky decomposition. The ordering is given as lnBMG →lnINF→lnUR, following the conventional transmission of monetary mechanism theory [18] which argues that the ordering is such that monetary conditions have an impact on prices prior to labor market outcomes.

Econometric testing procedures are done in the following way. The stationarity of each time-series variable is checked before the VAR model is estimated, using the Augmented Dickey–Fuller (ADF) test and the Phillips–Perron (PP) test [21] and [27]. The optimal lag length is then determined by the Akaike Information Criterion (AIC), Schwarz Bayesian Information Criterion (SBIC) and Hannan–Quinn Information Criterion (HQIC). Once the VAR model has been estimated, the short run causality test is performed to see if there are causal relationships between the variables [22]. Lastly, the stability of VAR is checked by the roots of the companion matrix: If all the roots are within the unit circle, the VAR is stable [20].

C. DATA COLLECTION

This paper uses 25 observations of annual time-series data for Australia from 2000 to 2024. The information is taken from the World Bank's World Development Indicators (WDI) database. These three variables are inflation rate (INF) in terms of the annual percentage change of the consumer price index, unemployment rate (UR) in terms of percentage of the total labour force and broad money growth (BMG) in terms of the annual percentage change of broad money supply. All three variables have positive values for the whole sample period and so the natural log is not used in the same way as the log of the absolute value. The log of the minimum value of lnINF (−0.163) is for a sub-unity inflation rate (less than 1 percent), and not a negative inflation rate in the original series. The data collected are analyzed using the software Stata version 17 which includes unit root tests, VAR model estimation, Granger causality analysis, residual diagnostics and system stability analysis.

IV. DATA ANALYSIS

Table 1 shows the descriptive statistics of the major variables investigated in the paper, i. e., inflation (lnINF), unemployment rate (lnUR), and the growth of broad money supply (lnBMG) in Australia, 2000-2024. In time-series studies of econometrics, descriptive statistics are often employed to summarize the central tendency, dispersion, and distributional characteristics of variables and then proceed with additional empirical research [23], [24]. The findings indicate that the mean of the inflation (lnINF) value is 0.952, and the standard deviation is 0.470, and this indicates that there is a moderate variability of inflation over the sample period. Minimum value of inflation is -0.163 and the maximum is 1.886 which indicates that inflation had been varying significantly among various economic periods. These movements could be a mirror of macroeconomic volatility and variations in monetary policy reactions with time. In the case of the unemployment rate (lnUR), the mean is 1.655 and the standard deviation is very small given that it is 0.167 which means that the state of unemployment remained relatively stable throughout the study. The values vary between 1.300 and 1.908, which shows moderate shifts of the labor market status in the various years. The dispersion is comparably low which indicates that the conditions of the Australian labor market were not extremely volatile in the period under consideration. Concerning the increase in money supply (lnBMG), the mean is 2.047 and the standard deviation is 0.529, which is more volatile than unemployment. The lowest figure of 0.863 and the greatest figure of 2.903 imply that there were significant changes in the monetary growth in various years. Such volatility can be an adjustment in the monetary policy and macroeconomic stabilization techniques introduced by the central bank. The value of skewness of all the variables

is near to zero and this shows that the distribution of these three variables inflation, unemployment, and money supply growth are relatively symmetric.

Moreover, the values of the kurtosis are near three which indicate that the variables are approximately distributed normally. The statistical theory states that variables whose kurtosis values are close to three tend to have the characteristics of a normal distribution [25]. Lastly, coefficient of variation reveals that inflation is the most relative variable with highest variation and unemployment is the least variable with the lowest variation. In general, the descriptive statistics show that the dataset has acceptable statistical characteristics and variation that would be used in further time-series econometric modeling like the VAR model.

Table 1. *Descriptive Statistics*

Desc. Stats	lnINF	lnUR	lnBMG
Obs	25	25	25
Mean	0.952	1.655	2.047
Std. Dev.	0.470	0.167	0.529
Min	-0.163	1.300	0.863
Max	1.886	1.908	2.903
Skewness	-0.160	-0.685	-0.340
Kurtosis	2.972	2.695	2.556
Coeff. of variation (CV)	0.494	0.101	0.258

Note: lnINF denotes inflation rate, lnUR denotes unemployment rate, and lnBMG represents broad money supply growth

Source: Authors' calculation using Stata 17



Figure 1. *Time Series Trends of Inflation, Unemployment, and Broad Money Growth in Australia (2000–2024)*

Figure 1 shows that inflation (lnINF), unemployment rate (lnUR), and growth of broad money supply in Australia (lnBMG) have evolved in a time-series over the years 2000-2024. Econometric analysis should also include visual inspection of time-series plots as it is an important preliminary step that allows identifying possible trends, structural changes, and fluctuations of macroeconomic variables [26]. The figure shows that inflation has recorded significant changes over the course of the study. Especially, it is clear that inflation declined during the global financial crisis period between 2009 and 2012 and spiked during the post-pandemic period between 2022 and 2023. These patterns coincide with periods of major global economic disruption, although the present study does not formally test for structural breaks and therefore cannot attribute these movements causally to the GFC or COVID-19 within the VAR framework. Unemployment rate shows relatively smooth trends as opposed to

inflation and money supply growth. Unemployment rose during economic downturns, particularly in the periods associated with the global financial crisis and the COVID-19 pandemic, before gradually declining. This trend is consistent with the classical lagged adjustment of labor markets through economic cycles. Conversely, the broad money supply growth is more volatile during the sample period, with notable expansions during periods of economic stimulus. In general, the time-series plots show that the variables have different levels of variation with time and hence require formal econometric testing to identify the statistical properties of the variables before estimating the models.

Table 2 shows the outcomes of the Augmented Dickey Fuller (ADF) and Phillips Perron (PP) unit root test which were conducted to test the stationarity of the variables. The idea of stationarity testing is an important procedure in time-series econometrics since non-stationary variables can cause spurious regression estimations when directly incorporated in empirical models [21], [23], [27]. The finding reveals that inflation (lnINF) and unemployment (lnUR) are not stationary at the level form because the ADF and the PP test statistics are not statistically significant. The two variables however turn out to be stationary following the first difference as the test statistics are significant at the 1% confidence level. This means that these variables are order one, I (1). Conversely, money supply growth (lnBMG) is observed to be at the level form as both the ADF and PP tests show. The t-statistic values are significant and this means that the null hypothesis of unit root is rejected. Thus, lnBMG may be said to be integrated of order zero, I(0). The results of the unit root test in general indicate the mixed forms of integration of the variables. As a result, the dynamic relationships between the variables can be investigated with the help of appropriate econometric modeling methods, including the VAR framework. Despite the mixed integration orders, the VAR model is estimated in levels following Sims, Stock, and Watson (1990), who establish that short-run inference via Granger causality and impulse response analysis remains valid under mixed integration when long-run cointegrating relationships are not the primary focus.

Table 3 gives the findings of the lag order selection test which was applied to identify the best lag length to be used in the VAR model. A proper choice of a lag length is critical since having fewer lags can lead to missing significant dynamic information whereas having too many lags might decrease the effectiveness of estimation and build up a complex model [20]. Some of the frequently used information criteria include Akaike Information Criterion (AIC), Hannan-Quinn Information Criterion (HQIC), Schwarz Bayesian Information Criterion (SBIC) and Final Prediction Error (FPE). Based on the findings, most of the information criteria specifically AIC, HQIC and FPE indicate that the best lag length of the VAR model is one lag (p = 1). The choice of one lag shows that the dynamic relationships between inflation, unemployment, and growth of money supply can be satisfactorily defined on a VAR(1) specification. Hence, the ensuing empirical research in the current study is achieved via the VAR model, but with one lag.

Table 2. *ADF Unit Root Test Results*

Variables	Level ADF	Level PP	First Difference ADF	First Difference PP
lnINF	-2.732	-2.976	-4.813***	-5.620***
lnUR	-2.381	-2.004	-4.141***	-4.287***
lnBMG	-3.520**	-5.006***	—	—

Notes: ***p < 0.01, **p < 0.05, *p < 0.10. The results indicate that lnINF and lnUR are non-stationary at levels but become stationary after first differencing. In contrast, lnBMG is stationary at level according to both the ADF and Phillips–Perron tests

Source: Authors' calculation using Stata 17

Table 3. *Lag Selection Test Results*

Lag	LL	LR	df	p-value	FPE	AIC	HQIC	SBIC
0	12.921	–	–	–	0.000	1.384	1.422	1.533
1	1.068	27.978	0	0.001	0.525*	0.951*	1.100*	1.543
2	9.289	16.442	0	0.058	0.590	1.018	1.279	2.055

Where: LL is log likelihood; FPE is final prediction error; AIC is Akaike information criterion; HQIC is Hannan–Quinn information criterion; SBIC is Schwarz Bayesian information criterion

Source: Authors' calculation using Stata 17

Table 4. *VAR(1) Estimation Results with GFC and COVID-19 Dummy Variables*

Variables	lnINF	lnUR	lnBMG
Lagged endogenous variables			
lnINF (t−1)	0.2490	0.0863*	0.0748
	(0.1865)	(0.0436)	(0.2551)
lnUR (t−1)	−0.5473	1.0344***	0.4984
	(0.5981)	(0.1398)	(0.8179)
lnBMG (t−1)	0.1094	−0.0670	0.0865
	(0.1646)	(0.0385)	(0.2252)
Exogenous dummy variables			
d_GFC	−0.2311	0.2144***	−0.0408
	(0.3346)	(0.0782)	(0.4576)
d_COVID	−1.1227***	0.3505***	0.5567
	(0.3996)	(0.0934)	(0.5465)
Constant	1.4484	−0.0530	0.9783
	(1.1187)	(0.2616)	(1.5300)
R^2	0.3902	0.7372	0.0729
RMSE	0.4117	0.0963	0.5631
Obs	24	24	24

Notes: *** p < 0.01, ** p < 0.05, * p < 0.10. Standard errors in parentheses. d_GFC = 1 for 2008–2009, 0 otherwise. d_COVID = 1 for 2020, 0 otherwise. Source: Authors' calculation using Stata 17.

Table 4 presents the estimation results of the VAR(1) model augmented with GFC and COVID-19 dummy variables. Regarding the lagged endogenous variables, the coefficient of lagged inflation (lnINF) is positive at 0.249, marginally significant at the 10% level in the lnINF equation, indicating mild inflation persistence over time. This is consistent with the notion of inflation inertia, whereby past inflation carries forward predictive power for current inflation [18], [20]. In the unemployment equation, the coefficient of lagged unemployment (lnUR) is 1.034 and statistically significant at the 1% level, confirming strong persistence in labor market conditions. This implies that unemployment adjusts slowly to macroeconomic shocks, consistent with the hysteresis hypothesis [5], [28]. The coefficients of lagged money supply growth (lnBMG) are not statistically significant in any equation, suggesting that short-run fluctuations in money supply growth do not exert a direct and immediate influence on inflation or unemployment within the estimated VAR system. This result is consistent with Makin, Robson, and Ratnasiri (2017), who find that the short-run effect of money supply on Australian inflation weakened substantially following the adoption of inflation targeting, suggesting that the RBA's credible policy framework dampens the immediate transmission of monetary shocks.

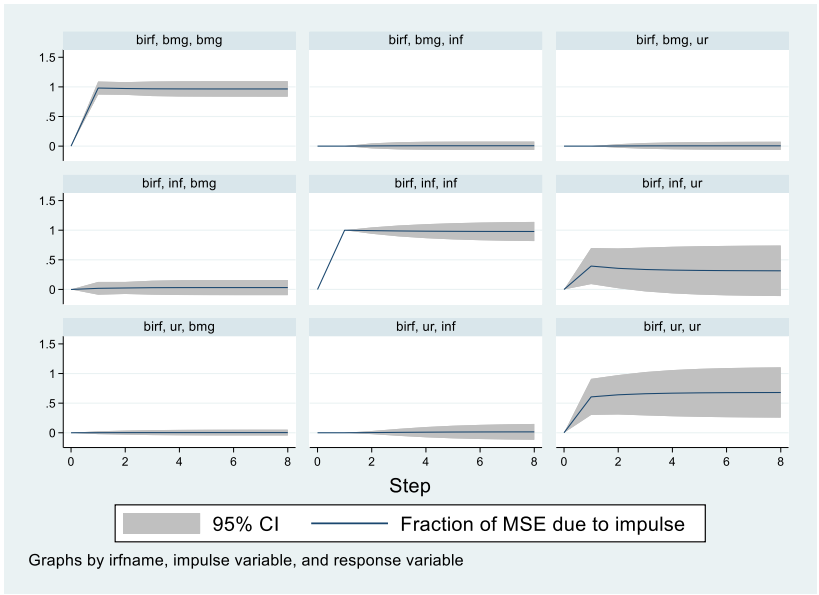


Figure 2. *Impulse–response functions*

Figure 2 shows impulse response functions (IRF) obtained by the VAR model. According to the responses, it is observed that inflation shocks are more likely to affect inflation in the short-term, but the response is smaller as time goes by implying that inflation shocks are also temporal and eventually fade away. Equally, unemployment shocks also have persistent effects on the unemployment series, which is in line with the high autoregressive nature of the estimate produced by the VAR estimation. The effect of money supply shocks on inflation and unemployment is also quite small and tends to zero in the long run meaning that the transmission of monetary shocks to these variables in the short run does not seem very strong. Generally, the impulse response analysis confirms that the dynamic interactions between the variables are not very strong as majority of the responses level off after a few periods.

Table 5. *Granger Causality Wald Test Results (VAR with GFC and COVID-19 Dummies)*

No.	*Null hypothesis*	*Lag*	*Chi-square*	*p-value*	*Result*
Dependent variable: lnINF					
1	*lnUR does not Granger-cause lnINF*	*1*	*0.837*	*0.360*	*Not rejected*
2	*lnBMG does not Granger-cause lnINF*	*1*	*0.441*	*0.506*	*Not rejected*
3	*lnUR and lnBMG do not Granger-cause lnINF*	*1*	*1.140*	*0.565*	*Not rejected*
Dependent variable: lnUR					
4	*lnINF does not Granger-cause lnUR*	*1*	*3.918*	*0.048*	*Rejected ** *
5	*lnBMG does not Granger-cause lnUR*	*1*	*3.032*	*0.082*	*Not rejected*
6	*lnINF and lnBMG do not Granger-cause lnUR*	*1*	*6.575*	*0.037*	*Rejected ** *
Dependent variable: lnBMG					
7	*lnINF does not Granger-cause lnBMG*	*1*	*0.086*	*0.769*	*Not rejected*
8	*lnUR does not Granger-cause lnBMG*	*1*	*0.371*	*0.542*	*Not rejected*
9	*lnINF and lnUR do not Granger-cause lnBMG*	*1*	*0.372*	*0.830*	*Not rejected*

*Notes: ** p < 0.05. The VAR model includes d_GFC and d_COVID as exogenous regressors. The null hypothesis states that the excluded variable(s) do not Granger-cause the dependent variable. Source: Authors' calculation using Stata 17.*

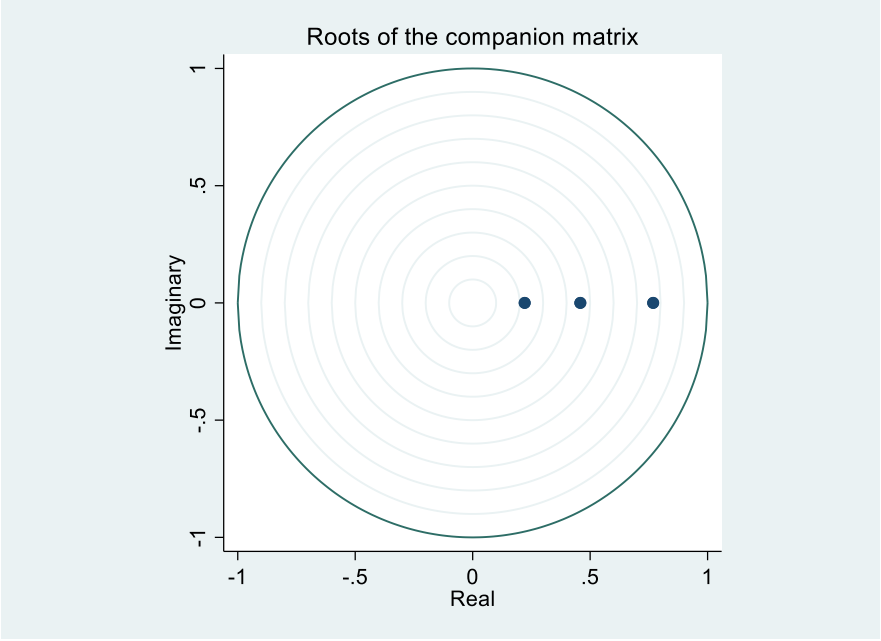


Figure 3. *VAR stability test using eigenvalues*

Roots of the companion matrix are used to investigate the stability condition of the VAR model. As Figure 3 indicates, all roots are within the unit circle which implies that the VAR system meets stability conditions. This

proves that the estimated VAR model is dynamically stable and can be used to analyze the impulse response and decomposition of variance.

To validate the reliability of the VAR(1) estimates with dummy variables, residual diagnostic tests are conducted. The Lagrange Multiplier test finds no evidence of serial correlation at lag 1 ($chi^2(9) = 12.467$, $p = 0.188$) or lag 2 ($chi^2(9) = 5.534$, $p = 0.785$), indicating that the chosen lag length remains adequate. Table 6 presents the ARCH LM test results for conditional heteroskedasticity. As all p-values exceed the 0.05 significance level, the null hypothesis of no ARCH effects is not rejected for any equation, confirming that the homoskedasticity assumption is satisfied. The Jarque–Bera normality test indicates that residuals from all three equations are approximately normally distributed: lnINF ($chi^2(2) = 0.650$, $p = 0.722$), lnUR ($chi^2(2) = 0.834$, $p = 0.659$), and lnBMG ($chi^2(2) = 0.593$, $p = 0.743$), with the joint test also passing ($chi^2(6) = 2.077$, $p = 0.912$). Notably, the non-normality previously observed in the lnUR equation in the baseline model is fully resolved upon inclusion of the GFC and COVID-19 dummy variables, confirming that the earlier departure from normality was attributable to these structural shocks rather than to model misspecification. Overall, the diagnostic results confirm the statistical adequacy of the estimated VAR model.

Table 6. ARCH LM Test Results for VAR(1) Residuals

Equation	LM statistic	df	p-value	Result
lnINF	2.059	1	0.151	No ARCH effects
lnUR	0.193	1	0.660	No ARCH effects
lnBMG	3.229	1	0.072	No ARCH effects

Notes: LM statistic = $n \times R^2$ from regressing squared residuals on their first lag, distributed $chi^2(1)$ under H_0 of no ARCH effects. H_0 is not rejected at the 5% significance level for any equation, supporting the assumption of homoskedastic residuals. Source: Authors' calculation using Stata 17.

V. DISCUSSION

This study was to consider a dynamic relationship of inflation and unemployment and an increase in money supply in Australia within the period of 2000-2024 through a VAR framework. To begin with, when considering the dynamic relationship between the variables, the estimation results of the VAR indicate that the inflation and unemployment are highly dependent on themselves past values as opposed to having close interactions with other macroeconomic variables. Prior to discussing the core VAR results, it is worth noting the role of the exogenous dummy variables. The COVID-19 dummy (d_COVID) enters the lnINF equation with a statistically significant negative coefficient (−1.123, $p = 0.005$), reflecting the sharp and atypical decline in inflation observed in 2020. In the lnUR equation, both d_GFC (0.214, $p = 0.006$) and d_COVID (0.351, $p = 0.000$) are positive and highly significant, consistent with the well-documented unemployment spikes associated with these crisis episodes. The results do support the hypothesis that accounting for GFC and COVID-19 shocks is important to separate out the underlying macroeconomic dynamics from the extraordinary shock effects. Specifically, the lagged value of inflation has a weak and positive impact on current inflation and this shows that there is inflation persistence. Such a discovery aligns with the idea of inflation inertia that is a common macroeconomic time series where the past inflation has a significant role to play in determining the current inflation [28]. Likewise, the unemployment equation indicates a strong and statistically significant impact of its lagged value indicating that the labor market circumstances change slowly with time. Such unemployment dynamics consistency can be explained by hysteresis hypothesis of labour market in that temporary economic shocks can obtain enduring impacts on unemployment rates [5], [29]. Second, it can be seen from the results that short-term changes in money supply do not significantly affect inflation rate or unemployment in the estimated VAR system. This observation implies that the transfer of monetary expansion to macroeconomic performances may not be instant especially in those economies that have relatively stable monetary policy systems. When applied to the case of Australia, the inflation-targeting regime conducted by the Reserve Bank of Australia can possibly help in dampening the direct short-run impacts of the money supply variation on the inflation and labor market. This interpretation is supported by Makin, Robson, and Ratnasiri (2017), who find empirically that the link between money supply growth and Australian inflation weakened considerably following the introduction of inflation targeting in 1993. It should be noted, however, that this explanation remains a plausible interpretation rather than a confirmed finding, as the present study does not include a structural break test or sub-sample analysis to formally verify this mechanism. This can be noted alongside the older studies in macroeconomics which have indicated that the monetary policy effect can be time lagging and can be affected by expectations and institutional consideration [8], [9], [30]. Third, the impulse response analysis gives further insight about the dynamic adjustment of the variables in response to the economic shocks. The impulse response functions indicate that, shocks to inflation produce

observable short-run effects in inflation per se, which however tend to decrease over time. In the same way, the response to unemployment shocks is persistent, which indicates low adjustment processes in the labor market. On the contrary, inflation and unemployment responses are relatively small to the shocks of money supply and are likely to move to zero in the long run. The findings indicate that the dynamic interactions between the variables are not that rich and that the majority of the shocks pass away over time within several periods. This is in line with the theoretical characteristics of the VAR systems, in the macroeconomic analysis whereby the economic variables tend to follow an autoregressive nature [18], [20]. Fourth, the Granger causality tests indicate an interesting result that only after the structural shocks are controlled. In particular, the null hypothesis of no Granger-causality between lnINF and lnUR is rejected at the 5% significance level ($chi^2(1) = 3.918$, $p = 0.048$); similarly, the test of the joint hypothesis of no Granger-causality between lnINF and the Granger-causality of lnBMG is significant at the 5% level ($chi^2(2) = 6.575$, $p = 0.037$). It means that, when the effect of the GFC and COVID-19 on inflation is removed, inflation has short-term forecasting ability for unemployment. In general, this result provides evidence consistent with the Phillips curve framework, which suggests that there is a short-run trade-off between inflation and employment [10, 11]. In contrast, the results of the Granger causality tests indicate that there is no significant causal relationship from lnUR or lnBMG to lnINF; or from lnINF or lnINF to lnBMG, implying that the money supply growth in Australia is largely exogenous to the short-run movements of inflation and unemployment in the sample period. However, it is recognized that the other non-significant results may be due in part to the limited statistical power of the Granger causality tests in small samples and subsequent research with higher frequency quarterly data would give more definitive results. Lastly, the stability test ensures that the companion matrix is stable i.e., all the roots of the companion matrix fall within the unit circle, meaning that the approximated VAR model meets the stability condition. Stable VAR system is the one which ensures the reliability and economic meaningfulness of the impulse response as well as other dynamic analyses [20]. This discovery will help them substantiate the empirical findings of their study and will validate the model that they have been approximating.

Overall, the empirical results suggest a short-run statistically significant Granger causal relationship from inflation to unemployment, which is in line with the Phillips curve framework, after controlling for large structural shocks. In addition to this, the short-run evolution of unemployment and money supply growth continues largely as it has done in the past, with little support for strong cross-variable causal relationships. The findings of this study highlight the need to consider extraordinary macroeconomic events in order to model the dynamic relationship between key macroeconomic indicators. This study is based on the Australian context but the lessons learned provide guidance for other emerging economies where macroeconomic stabilisation and inflation control are major policy concerns, particularly Vietnam. The results, however, should be interpreted with caution because they apply to a single country and not to the broader economy, a level of monetary policy credibility that may differ across countries, and a monetary transmission mechanism that can vary between economic contexts.

VI. CONCLUSION

This study examines the dynamic relationship between inflation, unemployment, and money supply growth in Australia over the period 2000–2024. The study will use the annual time-series data of the World Development Indicators database to analyze the relationship between these major macroeconomic variables across time and the presence of short-run causal relationships among them.

The empirical results give some useful information. To begin with, the results of the estimation of the VAR show that the inflation and unemployment levels are highly persistent i.e. the present value of the variables is highly dependent on the past values of the variables. This shows that price moves and labor market situations will be slow in responding to shocks in the economy as opposed to instantaneous responses. Second, during the analysis, it is found that the increase in money supply does not significantly affect the inflation or unemployment in the short-run when compared to the estimated model. This observation implies that the conduction of monetary policy to macroeconomic outcomes could be time-lags or more complicated processes. Third, the impulse response analysis shows that majority of the shocks in the variables are usually likely to go down with the period of time, whereas the Granger causality tests, after controlling for GFC and COVID-19 structural shocks via exogenous dummy variables, reveal a statistically significant short-run predictive relationship from inflation to unemployment, consistent with the Phillips curve framework, while no significant causal relationships are found involving money supply growth. Lastly, the stability test warns that the VAR model meets the stability condition, and the reported results are credible in the dynamic analysis. This research has a number of contributions to the existing macroeconomic literature. First, it presents current empirical results about the dynamic relationship between inflation, unemployment and money supply growth in the Australian economy based on a current data to cover between 2000 and 2024. Second, using a VAR framework, the study enables to investigate the feedback effects between macroeconomic factors without any rigid theory considerations. Third, the given analysis targets

the Australian context, but the results can also provide valuable ideas to some emerging economies including Vietnam because inflation issues and macroeconomic stability are also considered significant policy targets.

However, in spite of such contributions, the study has a number of limitations. Annual data is used in the analysis, and may not be sufficient to reflect short-term variations of macroeconomic variables. The more important limitation is on model specification, however, as just three variables are included in the VAR system — inflation, unemployment, and broad money growth — an extensive analysis of Australian monetary policy dynamics must also take into account variables like the RBA's main policy instrument, the cash rate, GDP growth or the output gap, the exchange rate, and inflation expectations. The lack of these variables is a significant drawback of the present study and their absence could introduce omitted variable bias into the study, and may directly impact on the result that broad money growth has no short-run effect on inflation and unemployment. New replications with more model specifications are strongly encouraged. In addition, the integration orders of variables are mixed, and the relatively small sample size results in less precise estimates, and there is no structural testing for a break in the time series, so it is not possible to formally assess the impact of the GFC and COVID-19 on macroeconomic dynamics in the current framework.

As mentioned above, there are several more lines of research that could be taken in the future. The use of higher frequency (quarterly) data would substantially increase the effective sample size and thus increase the statistical power of the Granger causality tests. The inclusion of further macroeconomic variables, such as the cash rate, growth in the economy, exchange rates and inflation expectations, would provide a more comprehensive understanding of the monetary transmission mechanism in Australia. The impact of the GFC and COVID-19 could be tested formally (e.g., Bai–Perron tests) and by performing sub-sample analysis. The Toda–Yamamoto causality procedure could be also applied as a robustness test for Granger causality for mixed integration orders. In addition, cross-country/regional analysis would illuminate the link between money supply growth, unemployment and inflation across countries/regions in the face of institutional differences and monetary policy frameworks. Overall, this paper has highlighted the need to explore the relationship between key macro-economic variables and provided an empirical benchmark for policymakers to gain insights into inflation and labour market developments in current economies.

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KHẢO SÁT MỐI QUAN HỆ ĐỘNG GIỮA LẠM PHÁT, THẤT NGHIỆP VÀ TĂNG TRƯỞNG CUNG TIỀN: BẰNG CHỨNG TỪ MÔ HÌNH VAR TẠI ÚC

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TÓM TẮT — Ở cả các nền kinh tế phát triển và đang phát triển, ổn định kinh tế vĩ mô luôn là một trong những mục tiêu quan trọng của chính sách kinh tế. Lạm phát, thất nghiệp và tăng trưởng cung tiền là những chỉ số kinh tế vĩ mô quan trọng phản ánh sự biến động của mức giá, tình trạng thị trường lao động và định hướng chính sách tiền tệ. Bài báo này nghiên cứu mối quan hệ động giữa lạm phát, thất nghiệp và tăng trưởng cung tiền tại Úc trong giai đoạn 2000–2024. Dựa trên dữ liệu chuỗi thời gian hàng năm được thu thập từ cơ sở dữ liệu World Development Indicators của Ngân hàng Thế giới, nghiên cứu sử dụng mô hình Vector Autoregression (VAR) để phân tích mối quan hệ tương tác giữa các biến kinh tế vĩ mô này. Kết quả thực nghiệm cho thấy cả lạm phát và thất nghiệp đều có tính bền vững cao, cho thấy giá trị hiện tại của các biến này chịu ảnh hưởng mạnh từ các giá trị trong quá khứ. Ngược lại, nghiên cứu không tìm thấy bằng chứng thống kê cho thấy tăng trưởng cung tiền có tác động ngắn hạn đáng kể đến lạm phát và thất nghiệp trong mô hình VAR ước lượng. Thông qua phân tích phản ứng xung lực, tác động của các cú sốc đối với các biến giảm dần theo thời gian, trong khi kiểm định nhân quả Granger cho thấy không tồn tại mối quan hệ nhân quả ngắn hạn giữa tăng trưởng cung tiền, lạm phát và thất nghiệp. Kiểm định tính ổn định cũng cho thấy mô hình VAR ước lượng đáp ứng điều kiện ổn định. Tuy nhiên, sau khi kiểm soát tác động của Khủng hoảng Tài chính Toàn cầu và COVID-19 thông qua các biến giả ngoại sinh, lạm phát được tìm thấy có quan hệ nhân quả Granger đến thất nghiệp trong ngắn hạn, phù hợp với lý thuyết đường cong Phillips.

Nhìn chung, kết quả nghiên cứu cho thấy các động thái ngắn hạn của lạm phát và thất nghiệp tại Úc chủ yếu được quyết định bởi các động lực nội tại của chính chúng hơn là bởi mối quan hệ trực tiếp với tăng trưởng cung tiền. Mặc dù nghiên cứu được thực hiện trong bối cảnh nền kinh tế Úc, các phát hiện này cũng có thể mang lại những gợi ý hữu ích cho các nhà hoạch định chính sách tại các nền kinh tế đang phát triển như Việt Nam, nơi mà việc duy trì ổn định kinh tế vĩ mô và kiểm soát lạm phát vẫn là mục tiêu chính sách quan trọng.

Từ khóa— Lạm phát, Thất nghiệp, Tăng trưởng cung tiền, Ổn định kinh tế vĩ mô, Úc



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