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Austrian Business Cycle Theory: Evidence from Kansas Agriculture

Levi A. Russell and Michael R. Langemeier

ABSTRACT: The popularity of the Austrian Business Cycle Theory (hereafter ABCT) continues to grow in both the popular press and the mainstream of the economics profession. That the ABCT is increasingly subjected to conventional empirical analysis is a testament to its intuitive appeal. In first-world economies, the agriculture sector is characterized by investment in expensive and highly-specialized equipment. While some agricultural products are "close to consumption," the network of highly specialized processing and transportation equipment necessary for the functioning of modern agriculture indicates that this sector is characterized by more roundabout production processes. Since the ABCT is primarily a theory of malinvestment in the more roundabout stages of production, analysis of the agricultural sector of the economy is relevant to the study of ABCT. This paper examines data for the production agriculture industry to determine whether business cycles in industry are consistent with the ABCT. Time series analysis using vector autoregression and other methods is conducted. Results are mixed, but strong arguments in favor of ABCT effects in agriculture are made.

KEYWORDS: agriculture, Austrian Business Cycle Theory, VAR

JEL CLASSIFICATION: Q14, E3, B53

Levi A. Russell (lrussell@tamu.edu) is Assistant Professor and Extension Economist in the Department of Agricultural Economics at Texas A&M University. Michael R. Langemeier (mlangeme@purdue.edu) is the Associate Director of the Center for Commercial Agriculture in the Department of Agricultural Economics at Purdue University. The authors appreciate helpful comments from an anonymous reviewer.

INTRODUCTION

Though it is considered a "heterodox" school of economics, Austrian Economics is one of the fastest growing schools. One of the best-known elements of Austrian theory is the Austrian Business Cycle Theory (hereafter ABCT). This theory has received increased attention (whether positive or negative) in the popular press (a Google search of "Austrian Business Cycle Theory" under the "News" tab returned 1,990 results on June 25, 2014) and in academic studies (Laidler, 2011; Bordo and Landon-Lane, 2013).

ABCT is a theory of malinvestment (De Soto, 2009, p. 375). The central proposition is that the market rate of interest is driven below the rate of time preference that prevails in society (Garrison, 2001, ch. 4). This is accomplished by an increase in the supply of money. The time preference that prevails in society is known as the "natural rate of interest" and was developed by Wicksell (Wicksell, 1962). Since interest rates are driven below equilibrium, the quantity demanded of loanable funds is now higher and the quantity supplied of loanable funds now lower than they otherwise would have been. Investment is now unsustainably higher than its equilibrium level. At the same time, consumption is higher because the incentive to save is lower. This constitutes the overinvestment portion of the theory. As to malinvestment, the increase in the money supply has so-called Cantillon effects on the economy (Garrison, 2001, ch. 4). The structure of capital in the economy is changed by the unsustainable increases in investment and consumption. This structure of capital can be conceived of as the various complementary relationships between various capital goods (Garrison, 2001, ch. 4; Lewin, 2011, p. 122). Investments are made which would not otherwise be made, since the costs of those investments are below equilibrium levels. Since the Austrian view conceives of the economy as a complex structure instead of a series of aggregates, the Cantillon effects are important. Some industries enjoy increases in output prices which are higher than others. These changes in relative prices result in unsustainable investment which affects some industries more than others. Overall, during the boom, investment and consumption are high. Prices in consumer goods industries and industries farthest removed from consumption in the structure of production are higher than prices in industries in the intermediate stages.

The onset of the bust comes when interest rates begin to increase and converge toward the natural rate. This condition is met either when the monetary authority sees fit to influence rates higher or when rates on the market begin to rise, as expectations of inflation are brought to bear (De Soto, 2009, p. 375). Investments are liquidated, but since some capital investments are, to varying degrees, specific to certain production processes, this liquidation can take time. Unemployment results, as skill sets are specific to certain production processes. To the extent that retooling and retraining are hindered or costly, the bust will persist. Output as a whole declines as liquid funds from divested capital are reorganized into productive investments. Once the structure of production is again consistent with resource availabilities and tastes and preferences, the economy can resume sustainable growth (Garrison, 2001, ch. 4). The recession of 1920/21 is often cited as a prime example of ABCT (Woods, 2009).

Though there are few studies claiming to test or illustrate ABCT via econometric means relative to other theories, such studies have largely found favorable results. Wainhouse (1984) used Granger causality tests on output data from 1959 to 1981 to determine whether a monetary origin of the business cycle existed. Results were generally favorable, suggesting that ABCT had empirically-demonstrated explanatory power.

Bismans and Mougeot (2009) used a panel regression approach with data from France, Germany, UK, and USA from 1980 to 2006 to determine whether effects consistent with ABCT could be found in the data. The study focused on changes in the term spread of interest rates (a proxy for the difference between natural and market interest rates) as a driver of changes in GDP. The authors did not explicitly account for changes in monetary policy, relying instead on Bernanke (1990) to indicate that monetary shocks explain 55 percent of the variation in the term spread.

Recent work in the econometric examination of ABCT (Keeler, 2001; Bismans and Mougeot, 2009; Mulligan, 2006) used observed changes in the term structure of interest rates as a proxy for changes in the difference between the Wicksellian natural and market interest rates. The use of the term structure as a proxy for this difference was criticized by Carilli and Dempster (2008). They suggested that the use of the term structure of interest rates was based on the Expectations Theory of the term structure, which was suspect. Further, they suggested that a measure of the difference between the natural and market rates of interest should be independent of monetary policy actions. In the place of the term structure of interest rates, Carilli and Dempster (2008) used both the real growth rate of GDP and the ratio of savings to consumption as proxies for the natural rate of interest and the federal funds rate as the market rate.

The present work purports to test for ABCT effects using output data from the production agriculture industry (defined as the use of arable land to grow crops or to raise livestock) as a proxy for an early-stage industry. We defend the selection of production agriculture as an early stage industry on the basis that 1) it is a capital-intensive industry, 2) its assets are highly specialized, and 3) its products are relatively distant from final consumption.

Previous work has examined ABCT effects in early-stage industries. Mulligan (2002) examined early-stage industries from a capacity utilization standpoint and Young (2005) used employment statistics to test the Hayekian version of ABCT. This study differs in that it focuses on the net production of the agricultural sector. In this way, it is similar to other studies which focus on net aggregate production of final goods (Carilli and Dempster, 2008; Bismans and Mougeot, 2009). Thus, the use of output statistics in an early-stage industry is a contribution of this study to the existing literature.

DATA

To specify the variables used in this study, six data series were used. The time series data included information from 1973 to 2010. To approximate the changes in reserves resulting from monetary policy, annual data on money at zero maturity (MZM) was obtained from the St. Louis Federal Reserve FRED database. Money at zero maturity is defined as the M2 money supply less time deposits plus money market funds.

The gap between the natural rate and the market rate of interest (GAP) was also approximated with data from FRED. The market rate of interest is specified as the annual effective federal funds rate. Since, as Carilli and Dempster (2008) and Murphy (2003) indicate, liquidity preference is a key determinant of interest rates, the present authors believe that the use of the real growth rate of GDP as a proxy for the natural rate of interest is suspect. Thus, following Carilli and Dempster (2008) and Rothbard (2001), we specify the ratio of savings to consumption as a proxy for the natural rate. To approximate output in Kansas agriculture (OUTPUT), annual data on net farm income and value of farm production (gross margin) were obtained from the Kansas Farm Management Association dataset. Output is specified as the ratio of net farm income to value of farm production. This is done to eliminate the effect of prices on output.

The authors use profit to measure *net* output. This ensures that the econometric analysis is focused on the contribution of this particular stage (production agriculture) to the total output of the economy. Due to the stage- and location-specificity of the data, the authors used value of farm production to net out the effects of changes in the value of the dollar rather than conventional price indices. Conventional price indices would not accurately account for changes in agricultural product prices since the specific types and quality of agricultural output has changed drastically over the period of the study. All data series from FRED were converted to real values using the chain type price index on personal consumption expenditures.

To determine whether each series is stationary, Augmented Dickey Fuller tests were conducted. The results can be found below in Table 1. All three series were nonstationary in levels, so it was necessary to difference them. The percentage change was calculated for MZM and OUTPUT. For GAP, the first difference was taken.

METHODS

To determine whether output statistics from production agriculture are consistent with the ABCT, the complex theory was distilled into two propositions: that changes in reserves impact the interest rate gap, and changes in the interest rate gap impact output of production agriculture. Recall that GAP is defined as the difference between the natural rate of interest and the federal funds rate. If, *ceteris paribus*, the federal funds rate is pushed down (pushed up), or if the natural rate rises (falls), GAP increases (decreases). Further, it was necessary to find an endogenous turning point in the data where the interest rate gap indicates, first, a rise in output followed by a fall in output. This was done to differentiate between the claims of the ABCT and the claims of the Monetarists (namely that policymakers can influence output when inflation expectations are high). These two models are approximations of those used in Carilli and Dempster (2008).

To estimate the first model, a structural vector autoregression (SVAR) was estimated. The SVAR was used because it allows for relationships between contemporaneous values of the regressors whereas standard VAR analysis does not. This is a departure from Carilli and Dempster (2008). To determine the number of lags, the Akaike information criterion was used. The results are found in Table 2. A lag length of 3 was chosen based on this test.

To determine whether the causal relationships elucidated in the first model were a feature of the data, Granger causality tests were conducted. Granger causality is not a test of causation in the conventional sense; it merely shows whether or not there is significant evidence that lagged values of one variable improve the forecasts of another variable. Still, it is important in deciphering whether or not changes in MZM are leading indicators of changes in the interest rate gap and whether or not changes in the interest rate gap are leading indicators of changes in agricultural output.

There was not statistically significant evidence of a Granger-causal relationship between MZM and GAP (Table 3). That is, lags of MZM do not improve forecasts of GAP. However, there was a statistically significant relationship between changes in GAP and changes in OUTPUT. Lags of changes in the interest rate gap improved forecasts of changes in output. This result indicates that some statistically significant relationship exists between the interest rate gap (and therefore interest rate policy) and output in agriculture. Further tests are needed to explore this result in greater depth.

The next step in the analysis was to specify the coefficient matrix for the contemporaneous values of the regressors in the SVAR. To specify this matrix (Table 4), assumptions based on theory were necessary. Since there were three variables, it was necessary to specify three assumptions. For the equation with the percentage change in MZM as the left hand side variable, it was assumed that the other variables do not impact MZM in the current year. Since the Federal

Open Market Committee influences market rates via manipulation of bank reserves, it is unlikely that interest rates would impact reserves in the same period. Even if such effects exist, there are lags associated with monetary policy that would push these effects off to a later period. It is unlikely that production agriculture is large enough to have an impact on total reserves contemporaneously as well. Output in production agriculture may impact reserve levels if managers, overall, reduce or increase their debt loads in a relatively short period of time. However, this effect is likely to be delayed, since even short-term operating loans are secured before the production year. The third and final assumption was that output will not impact the interest rate gap in the same period. Market interest rates may be impacted if farmers change their debt loads, but again, this decision is made after that output is observed.

To further determine the impacts of changes in MZM on GAP and the impacts of changes in GAP on changes in OUTPUT, impulse response analysis and forecast error variance decompositions were estimated. This analysis will paint a more detailed picture of the relationships between these variables. The impulse response analysis (IRA) shows how an exogenous shock to one variable impacts other variables over time. This was important for determining whether the ABCT effects were features of the data. The forecast error variance decomposition (FEVD) gives the percentage of the forecast error variance of a given variable that is explained by exogenous shocks to all the variables over time. The results of this analysis will help to understand how much each variable was responsible for changes in the others from a forecasting standpoint.

The next element of the analysis was to estimate a polynomial distributed lag model. The purpose of this analysis was to determine whether or not an endogenous turning point exists in the data. That is, whether or not lags of GAP have a relationship to OUTPUT such that earlier lags were positively related and later lags were negatively related. The question being answered is whether or not the business cycle (in this case, increases followed by decreases in the output of a sector relatively distant from consumption) was a function of this gap. The polynomial distributed lag model estimated will be quadratic so as to capture the potentially-nonlinear relationship between GAP and OUTPUT.

Finally, the Diebold-Mariano (D-M) test was conducted. This test was designed to determine whether one of a pair of variables was better at forecasting a third. For the purpose of this study, the two predictor variables being compared were changes in MZM and changes in GAP. The findings will indicate to what degree the interest rate gap was necessary in the causal chain proposed above to predict OUTPUT.

RESULTS

Impulse Response and Forecast Error Variance Decomposition Analysis

To determine the relationships between MZM, GAP, and OUTPUT, impulse response analysis (IRA) was conducted on the SVAR coefficients (Table 5). Since GAP is the difference between the natural rate of interest and the federal funds rate, it should rise as MZM increases. The IRA (found in Table 6) displays some interesting results. An exogenous, one unit shock to the change in MZM results in a large increase in the change in the interest rate gap, as expected. This change eventually becomes negative at 4 steps ahead and returns to a positive (albeit small) value in period 7.

The initial positive effect of MZM on GAP which turns negative after 4 years indicates that changes in the money supply can only temporarily drive rates below their natural level. There is an endogenous turning point; an increase in the money supply will drive rates down in the near term, but rates must rise later because the pool of saved resources has not increased. This endogeneity differentiates ABCT from the claims of the Monetarists.

At 8 steps ahead, there is still a small, positive level effect on the change in the interest rate gap. In other words, a change in the money supply tends to drive a wedge between the natural rate and the market rate even after 8 years have passed. However, these results are suspect, as the Granger causality test found no evidence to support the notion that a change in MZM is a leading indicator of changes in the gap. The change in MZM also has an initially positive effect on the change in output. At 6 years ahead, this effect becomes negative and remains so through 8 years ahead.

The impulse response function analysis indicates that the ABCT effects on output may be a result of shocks to changes in MZM. The impacts of a shock to the change in the interest rate gap have very little effect at all on changes in output. It is necessary to be humble about all the results presented on the IRA because the confidence bands are extremely broad. This is likely a result of the small sample size.

The FEVD analysis (Table 7) further indicates that MZM is a relatively more powerful predictor of OUTPUT. Nearly all the variation in the forecast errors is a function of exogenous shocks to the change in MZM. That is, shocks to the change in the interest rate gap are not responsible for hardly any of the variation in the forecast errors for the change in output. This suggests that perhaps changes in MZM in this model have the most predictive power for the variables of interest. This is a somewhat strange result, as the Granger causality test for changes in the interest rate gap as a leading indicator of the changes in output was significant at the 10 percent level. More work is needed to decipher these seemingly conflicting results.

Polynomial Distributed Lag Function Analysis

The results of the polynomial distributed lag model (Almon, 1965) show, perhaps, the strongest evidence for ABCT effects in production agriculture. Lags of GAP are regressed on OUTPUT to determine whether effects predicted by ABCT exist. The model was estimated with a polynomial of degree two. According to the results (Table 8), the p-values on the linear and quadratic terms were both significant at the 5 percent level. The polynomial may be of a higher order, but it is at least quadratic.[1]

The lagged values exhibit features consistent with the ABCT and demonstrate the existence of an endogenous turning point. This endogenous turning point differentiates the Austrian theory from the Monetarist theory in that it demonstrates that interest rate manipulation creates mal-investments and overconsumption in the short run which must be liquidated and reduced in the long run.

[1] The Durbin-Watson test indicates white-noise errors. This indicates that the lag length selection is not problematic.

(Carilli and Dempster, 2008). The five earliest lags have positive coefficients (though they are not statistically significant at the 10 percent level) and the final three lags have negative coefficients. This implies that an innovation in GAP, which occurs when the market rate of interest is driven below the natural rate, initially raises OUTPUT for four years, after which OUTPUT falls. This result, coupled with the Granger causality tests, indicates ABCT effects in the data which are distinct from effects consistent with Monetarist theory. Only two of the coefficients for this model are significantly different from zero statistically. Again, this may be a problem of a small sample size.

Diebold-Mariano Test

The Diebold-Mariano test (Table 9) for differences in the forecast errors of two models was also conducted. The first model is the change in MZM predicting the change in OUTPUT. The second is the change in GAP predicting the change in OUTPUT. The null hypothesis is that the expected value of the difference between the squared errors is zero. If the null hypothesis is rejected, it indicates that the forecasting ability of the two models are different. If we fail to reject the null, it indicates that the forecasting ability of the two models are not statistically different. If forecasts in the two models are not statistically different, it indicates that the interest rate gap may not be the conduit through which changes in the money supply affect agricultural output.

A squared loss function was used to compute z-scores to determine if there is a statistically significant difference between the forecasting power of the two models. Recursive, pseudo-out-of-sample forecasts were estimated for the models starting in 1988. Forecasts for 1, 2, and 3 steps ahead were calculated and a squared loss function was used. As the z scores indicate, the difference between the forecast errors is not significantly different from zero.

Since changes in MZM and changes in GAP are both equally good leading indicators of changes in OUTPUT, it may be that changes in output are not explained very well at all by either. This indicates that neither model is better than the other at predicting changes in output. These findings contradict the results of the FEVD analysis. However, it is important to note that this paper makes use of annual data and that it may be difficult to distinguish statistically between innovations and, MZM and GAP.

CONCLUSION

The purpose of this study was to determine whether the observable data on the US monetary system and Kansas production agriculture are consistent with ABCT. The findings in this study are mixed. The Granger causality test and the polynomial distributed lag analysis indicate that changes in the interest rate gap are a good leading indicator of changes in agricultural output, and therefore that ABCT effects exist in the data.

Specifically, the results indicate that downside deviations in the interest rate gap have a nonlinear effect on output such that output is increased in the short run and decreases after a period of time. Since this nonlinear effect of the interest rate gap on output has an endogenous turning point, we suggest that this is evidence of the ABCT and not of Monetarist theories which do not predict an endogenous turning point. (Carilli and Dempster, 2008)

However, the IRA, FEVD, and D-M test analyses indicate that Federal Reserve policy is a better predictor of changes in agricultural output and that ABCT effects do not exist in the data according to the model presented. While monetary policy clearly has an effect on the interest rate gap, it is not clear based on the findings of these tests whether monetary policy affects the output of production agriculture through its effect on the interest rate gap. Additional research is needed to determine whether these results can be reconciled or whether more robust results can be found with similar data.

One of the primary difficulties with this analysis is determining whether MZM is a good indicator of reserves. Part of the problem here is that many Austrian business cycle theorists speak of the supply of money rather than reserves as the variable that is manipulated by the monetary authority. We have followed the method used by Carilli and Dempster (2008) in an earlier version of their paper. However, MZM was not used in the final version of their paper. More work is needed to determine the proper variable to specify the measure spoken of in the theory.

Another problem with this analysis is a lack of data. Future analysis will include finding a suitable proxy for production agricultural output to enhance the number of observations available. Another appropriate extension would be to use other specifications of the natural rate of interest.

REFERENCES

Almon, Shirley. 1965. "The Distributed Lag Between Capital Appropriations and Expenditures," *Econometrica* 33, no. 1: 178–196.

Bernanke, Benjamin. 1990. "On the predictive power of interest rates and interest rate spreads." *New England Economic Review* 3486: 51–68.

Bismans, Francis, and Christelle Mougeot. 2009. "Austrian Business Cycle Theory: Empirical Evidence," *Review of Austrian Economics* 22, no. 3: 241–257.

Bordo, Michael D., and John Landon-Lane. "Does Expansionary Monetary Policy Cause Asset Price Booms; Some Historical and Empirical Evidence," *NBER Working Paper Series*, 2013: Working Paper 19585.

Carilli, Anthony M., and Gregory M. Dempster. 2008. "Is the Austrian Business Cycle Theory Still Relevant?" *Review of Austrian Economics* 21, no. 4: 271–281.

De Soto, Jesus Huerta. 2009. *Money, Bank Credit, and Economic Cycles*. Auburn, Ala.: Ludwig von Mises Institute.

Garrison, Roger W. 2001. *Time and Money: The Macroeconomics of Capital Structure*. New York: Routledge.

Keeler, James P. 2001. "Empirical Evidence on the Austrian Business Cycle Theory," *Review of Austrian Economics* 14, no. 4: 331–351.

Laidler, David. 2011. "The Monetary Economy and the Economic Crisis," *Center for the History of Political Economy*.

Lewin, Peter. 2011. *Capital in Disequilibrium*. Auburn, Ala.: Ludwig von Mises Institute.

Mulligan, Robert F. 2002. "A Hayekian Analysis of the Term Structure of Production," *Quarterly Journal of Austrian Economics* 5, no. 2: 17–33.

——. 2006. "An Empirical Examination of Austrian Business Cycle Theory," *Quarterly Journal of Austrian Economics* 9, no. 2: 69–93.

Murphy, Robert P. 2003. "Unanticipated Intertemporal Change in Theories of Interest." Dissertation, New York University. Available at https://files.nyu.edu/rpm213/public/files/Dissertation.pdf.

Rothbard, Murray N. 2001. *Man, Economy, and State: A Treatise on Economic Principles*. Auburn, Ala.: Ludwig von Mises Institute.

Wainhouse, Charles. 1984. "Empirical Evidence for Hayek's Theory of Economic Fluctuations." In B. Siegel, ed., *Money in Crisis*, pp. 37–71. San Francisco: Pacific Institute for Public Policy Research.

Wicksell, Knut. 1962. *Interest and Prices*. New York: Sentry Press.

Woods, Thomas E., Jr. 2009. "Warren Harding and the Forgotten Depression of 1920," *The Intercollegiate Review* 44, no. 2: 22–29.

Young, Andrew T. 2005. "Reallocating Labor to Initiate Changes in Capital Structures: Hayek Revisited," *Economics Letters* 89, no. 3: 275–282.

APPENDIX

Table 1. Augmented Dickey-Fuller Tests

	type	t-stat	5% t-crit
MZM	trend	-0.083	-3.588
GAP	trend	-2.239	-2.994
OUTPUT	trend	-2.067	-3.588

Table 2. Lag Length Selection

	AIC
0	4.728
1	4.283
2	4.371
3	4.138*
4	4.390

* Minimum AIC indicates appropriate lag length

Table 3. Granger Causality Tests

Lags of:	Improve forecasts of:	p-value
MZM	GAP	0.302
GAP	OUTPUT	0.053*

* indicates significance at the 10% level

Table 4. SVAR Matrix of Coefficients on Contemporaneous Values

	MZM	GAP	OUTPUT
MZM	1	0	0
GAP	22.321	1	0
OUTPUT	1.767	0.036	1

Table 5. SVAR Estimation Results

Equation: MZM	Lag	Coefficient	P-value
MZM	1	0.925	0.000***
GAP	1	0	0.93
OUTPUT	1	-0.03	0.000***
MZM	2	-0.433	0.057*
GAP	2	-0.007	0.084*
OUTPUT	2	0.027	0.010***
MZM	3	0.074	0.62
GAP	3	-0.002	0.568
OUTPUT	3	-0.021	0.032**
Constant		0.013	0.252
Equation: GAP	**Lag**	**Coefficient**	**P-value**
MZM	1	12.499	0.209
GAP	1	-0.232	0.286
OUTPUT	1	0.033	0.925
MZM	2	-5.391	0.618
GAP	2	0.097	0.63
OUTPUT	2	0.441	0.363
MZM	3	-5.028	0.495
GAP	3	-0.298	0.061*
OUTPUT	3	-0.162	0.718
Constant		-0.279	0.622
Equation: OUTPUT	**Lag**	**Coefficient**	**P-value**
MZM	1	5.215	0.313
GAP	1	0.102	0.367
OUTPUT	1	0.066	0.719
MZM	2	2.205	0.696
GAP	2	-0.164	0.127
OUTPUT	2	-0.053	0.832
MZM	3	6.951	0.079*
GAP	3	0.14	0.090*
OUTPUT	3	0.109	0.643
Constant		-5.82	0.058*

* Indicates significance at the 10% level
** Indicates significance at the 5% level
*** Indicates significance at the 1% level

Table 6. Impulse Response Analysis

Impulse MZM	Response GAP	Response OUTPUT
1	22.321	1.767
2	7.369	7.617
3	6.893	4.206
4	-13.728	11.653
5	-5.930	4.201
6	-4.472	-1.482
7	6.057	-5.884
8	3.325	-2.830

Impulse GAP		Response OUTPUT
1		0.036
2		0.105
3		-0.190
4		0.120
5		-0.116
6		-0.048
7		-0.077
8		0.017

Table 7. Forecast Error Variance Decomposition

MZM	MZM	GAP	OUTPUT
1	1	0	0
3	0.999	0.000	0.001
6	0.999	0.000	0.000
8	0.999	0.000	0.000
GAP	**MZM**	**GAP**	**OUTPUT**
1	0.998	0.002	0.000
3	0.998	0.002	0.000
6	0.998	0.002	0.000
8	0.998	0.002	0.000
OUTPUT	**MZM**	**GAP**	**OUTPUT**
1	0.757	0.000	0.243
3	0.986	0.001	0.013
6	0.995	0.000	0.005
8	0.996	0.000	0.004

Table 8. Polynomial Distributed Lag Function

	Degrees of Polynomial Coefficient	p-value
Intercept	0.014	0.943
Constant	-0.025	0.856
Linear term	-0.288	0.005***
Quadratic term	-0.190	0.032**

Lags of GAP	Lag Distribution Coefficient	p-value
0	0.039	0.616
1	0.078	0.197
2	0.095	0.111
3	0.090	0.164
4	0.064	0.345
5	0.016	0.808
6	-0.054	0.365
7	-0.145	0.010**
8	-0.258	0.000***

Dubin-Watson Test Statistic
D-W = 1.752
*** indicates significance at the 1% level
** indicates significance at the 5% level
Dependent variable: OUTPUT

Table 9. Diebold-Mariano Test

steps	z-score
1	0.214
2	0.213
3	0.213