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The Effects of Gross Fixed Capital Formation and Money Supply on Economic Activity (A Time Series Analysis)

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□ ABSTRACT □

The main aim of this study is to investigate the effects of gross fixed capital formation and money supply on economic activity in Algeria over the period 1971-2003.To achieve this objective, a time series analysis technique has been applied to the three major variables of the study: gross fixed capital formation (GFCF), the narrow definition of money supply (M), and finally the gross domestic product (GDP) to stand as an indicator of economic activity. The results have, in general, found that gross fixed capital formation has a stronger effect on real gross domestic product than money supply. This implies that the Algerian government should focus on the level of investment rather than on monetary policy to stimulate economic growth.

Key words: Macroeconomics, Capital Formation, Money Supply, Time Series Analysis.

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أثر إجمالي التكوين الرأسمالي الثابت وعرض النقد على النشاط الاقتصادي (تحليل سلاسل زمنية)

الدكتور أحمد ابراهيم ملاوي*

(تاريخ الإيداع 29 / 3 / 2006. قبل للنشر في 2006/5/15)

□ الملخّص □

تهدف هذه الدراسة بشكل أساسي إلى استقصاء أثر كل من إجمالي التكوين الرأسمالي الثابت وعرض النقد على النشاط الاقتصادي في الجزائر خلال الفترة الزمنية (1971–2003).

ولتحقيق هذا الهدف تم تطبيق أسلوب تحليل السلاسل الزمنية على المتغيرات الرئيسية في الدراسة وهي: إجمالي التكوين الرأسمالي الثابت، عرض النقد، والناتج المحلي الإجمالي كمتغير ممثل للنشاط الاقتصادي.

وبشكل عام، بيّنت نتائج الدراسة بأن أثر إجمالي التكوين الرأسمالي الثابت يفوق أثر عرض النقد على النشاط الاقتصادي في الجزائر. وهذا يتضمن بأنه على الحكومة الجزائرية التركيز على الجانب الاستثماري لحفز النشاط الاقتصادي الجزائري.

الكلمات المفتاحية: اقتصاد كلي، تكوين رأسمالي، عرض النقد، تحليل السلاسل الزمنية.

* أستاذ مشارك، قسم الاقتصاد، كلية إدارة الأعمال، جامعة مؤتة، الأردن وحاليا في إجازة تفرغ علمي لمدة سنة في قسم الاقتصاد، كلية الاقتصاد والعلوم الإدارية، جامعة اليرموك، الأردن.

Introduction:

Raising the level of economic activity has always been the major concern of decision makers and economists. This concern comes from the importance of pinpointing the causes that may stand behind increasing economic activity, which in turn, has positive social, political, and economic consequences.

There are different reasons that may raise the level of economic activity; two of them are investment and money supply. In this study, investment is proxied by the gross fixed capital formation (GFCF), the narrow definition of money (M) will stand for the money supply (M), and finally the gross domestic product (GDP) will be used as an indicator for economic activity.

In Algeria, the nominal GDP grew up from 23.5 billion Dinars in 1971, to 391.8 billion Dinars in 1989, and reached 5124 billion Dinars in 2003 with an average growth rate of 18.33% over the period of study (1971-2003). Where in real terms (in 1995 prices), the real gross domestic product (RGDP) increased from 435.2 billion Dinars in 1971 to 1530.5 billion Dinars in 1989, and reached to 3483.3 billions Dinar in year 2003, with an average growth rate of 7.24% over the period 1971-1989, and 4.95% over the period 1990-2003, and of 6.72% over the whole period of study (1971-2003). On the other hand, the growth rates of GFCF and M have hovered between 14.84% and 18.21% over the period and subperiods of study as they are shown in table (1).

Table (1) Growth Rates of GDP, RGDP, GFCF, and M in Algeria (%)

Period	GDP	RGDP	GFCF	M
1971-1989	16.92	7.24	15.54	17.85
1990-2003	18.64	4.95	18.21	14.84
1971-2003	18.33	6.72	16.83	16.31

Notes: -GDP denotes nominal Gross Domestic Product.
- RGDP denotes real Gross Domestic Product (base year is 1995).
- GFCF denotes Gross Fixed Capital Formation.
- M denotes money supply (M1).
-All the percentages in this table are calculated based on the numbers that are reported in the International Financial Statistics Yearbooks (IFS).

The relativeness of GFCF to M (i.e. the percentage of GFCF to M) in Algeria started to be around 66.15% in 1971, decreased to 65.05% in 1980, increased to around 73.7% in 1992, and reached around 76.4% in year 2003. These are the percentages for some Arab countries and some other countries in two years: 1992 and 2003 reported in table (2).

It is very impressive to see from table (2) that the percentage of GFCF to M is, in general, very low in the Arab countries comparing to the other reported countries. This may give us an indicator that strong economies usually focus on investment rather than on money supply to keep their economies very strong, whereas developing countries focus on money supply, which might be neutral in the long run.

Table (2) Percentage of GFCF to M (%) in 1992 and 2003 for different countries

Country	1992	2003
Algeria	73.69	76.44
Jordan	61.14	58.14*
Egypt	85.95	72.82
Libya	20.21	42.92*
Morocco	49.38	32.90
Tunisia	128.85	103.57
Israel	375.99	206.56
Japan	107.82	292.30
South Korea	369.35	326.57
Singapore	155.58	102.20
Switzerland	100.43	36.69
United Kingdom	488.82	419.59
United States of America	102.49	153.61
Australia	145.70	117.24
Canada	120.90	83.40

Notes: - * denotes year 2002.
- GFCF denotes Gross Fixed Capital Formation.
- M denotes money supply (M1).
- All the percentages in this table are calculated based on the numbers that are reported in the International Financial Statistics Yearbooks (IFS).

The Importance and Objectives of the Study:

The importance of this study comes from the ability to show the relative effectiveness of GFCF and M on economic activity. This understanding would give indications to decision makers on which policy they must focus to stimulate economic activity.

However, the main aim of this study is to investigate the effect of GFCF and M on economic activity in Algeria over the period 1971-2003.

To achieve the goals of this study, a time series analysis technique has been employed to analyze the relative effectiveness of GFCF and M on real GDP.

Malawi (2006), has studied the dynamic interaction among six macroeconomic variables in Jordan over the period (1967-2002). These variables include: price level, money supply, government expenditures, output, private consumption, and gross fixed capital formation. His results have shown that gross fixed capital formation has greater effect on gross domestic product than on money supply.

Econometric Methodology:

This study utilizes the Granger-causality test, the decomposition of variance, and the impulse response functions to investigate the impact of the gross fixed capital formation (GFCF) and money supply (M) on economic activity (which is proxied by RGDP: real gross domestic product) in Algeria.

In this study, it is assumed thata three-dimensional multiple time series $Y_t = [RGDP_t, GFCF_t, M_t]$ has three variables, and the relationship among these variables is:

$$\mathbf{Y_t = V + A_1 Y_{t-1} + A_2 Y_{t-2} + ...+ A_n Y_{t-n} + u_t \quad .....(1)}$$

Where $V = [v_1, v_2, v_3]'$ is a (3x1) vector of intercept terms, the A_i's are (3x3) coefficient matrices; and u_t is white noise with nonsingular matrix Ω. The coefficients V, A_i's, and Ω are assumed to be unknown. The time series data will be used to estimate the coefficients. Also,

$RGDP_t$: is the Real Gross Domestic Product.

$GFCF_t$: is the Gross Fixed Capital Formation.

M_t: is the money supply (M1).

n: is the number of lags.

The model in equation (1) above is a reduced (or nonstructural) form vector autoregression (VAR) model. VAR methodology superficially resembles simultaneous-equation modeling in that we consider several endogenous variables together, and each endogenous variable is explained by its lagged or past values and the lagged values of other endogenous variables in the model; usually there are no exogenous variables in the model (Gujarati, 1995, pp 735-736). The difference between the nonstructural and structural VAR models is that the nonstructural one makes minimal theoretical demands on the structure of the model, where what we all need is to specify only two things: (i) the set of variables (endogenous and exogenous) believed to interact and (ii) the largest number of lags needed to capture most of the effects that the variables have on each other. On the other hand, the structural one implies that the specific relationships among variables are based (either formally or informally) on economic theory. But unfortunately, economic theory may not be sufficient to determine the right specification, i.e. the theory might be too complicated to allow one to precisely derive a specification from first principles (Pindyck and Rubinfeld, 1991, pp 353-354). So the major advantage of the reduced form test is that the results are not conditional on the complete specification of the behavioral equations (Dwyer, 1982). Also Hafer and Sheehan (1991) have stated in this regard that:

"Because VAR analysis doesn't require the specification of an underlying theoretical model, it has been used to study the linkages among macroeconomic variables across national borders".

The value of n (i.e. the number of lags) is chosen arbitrarily to be four, which is supposed to be enough for yearly data. Leiderman (1984) has chosen only two lags for annual data. Dayyat (2003) and Al-Majali (2003) have chosen the lag-length to be six for annual Jordanian data.

Annual data have been employed to achieve the objectives of this paper. The data were obtained from the International Financial Statistics Yearbooks (IFS).

Empirical Results:

The empirical results reported in this paper are based on annual observations for the 1971-2003 period. After running the time series tests, the researcher could get the following results:

1. Granger-Causality Test:

This test, which is based on F-statistics, has been carried out in this study. The test indicates whether the lags of a given variable in a particular equation help in forecasting the dependent variable of that equation one period ahead.

The results of the pairwise Granger Causality test for the three variables of this study are reported in table (3) below.

The results show each of both variables; Gross Fixed Capital Formation, and Money Supply Granger cause the level of Real Gross Domestic Product in Algeria.

Table (3): Granger Causality test

Null Hypothesis	F-Statistic	Probability	Decision
GFCF does not Granger cause RGDP	5.67	0.0032	Reject H_0^*
M does not Granger cause RGDP	2.55	0.071	Reject H_0^{**}

Notes: - GFCF denotes the Gross Fixed Capital Formation.
- RGDP denotes the Real Gross Domestic Product.
- M denotes the money supply (M1).
- (*) Rejection H_0 at less than 1%.
- (**) Rejection H_0 at less than 10%.
- The number of lags for this test is chosen to be (4), which is supposed to be enough to capture the effects for annual data.

2. Stability Test:

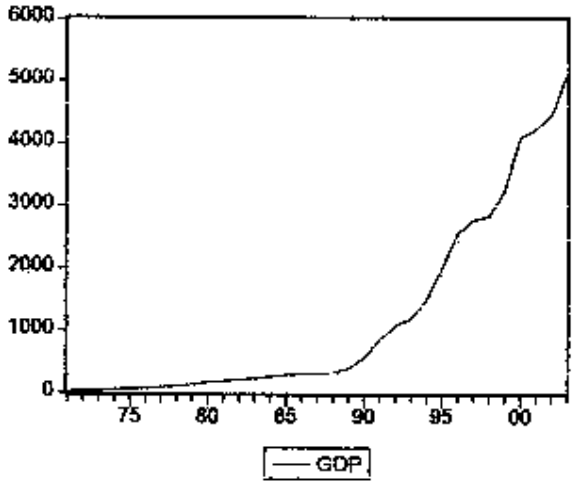
Since the data show an unusual change in their behavior over the period of study as shown from their graphs in figure (1), it is necessary to check if there are structural changes in the data. So, the researcher implemented two stability tests for the Ordinary Least Squares (OLS) estimation, where the dependent variable is RGDP and the two independent variables are GFCF and M. These two tests are CUSUM test and CUSUM of Squares test (CUSUMQ). The results of these two tests as shown in figures (2) and (3) show that the residuals are not inside plus and minus two standard errors band, which suggest instability in the parameters of the equation, which in turn implies that we cannot accept the null hypothesis of constant parameters for the whole period of this study at 5% level of significance. Of course the results of the stability tests tell us that we need to partition the period of study into parts. The researcher has partitioned the whole period (1971-2003) into (1971-1989) and (1990-2003), where it is obvious from the graphs in figure (1) that the numbers started to increase at an increasing rate after 1989, which can be explained by the fact that Algeria had a structural change in its economy, where it switched from communist to liberal economy in 1989 (Tommy and Shagabgab, 2005, P 34).

3. Unit Root Test:

Before choosing the best estimation method, it is necessary to check if the given variables are stationary. A very common test for that is the Augmented Dickey-Fuller (ADF) unit root test. The results of this test are reported in tables (4) and (5) for the subperiods 1971-1989 and 1990-2003 respectively.

Since the three variables; RGDP, GFCF, and M are not stationary at their levels and they are integrated into different orders, using the OLS estimation method gives spurious results. To solve this problem, the researcher has resorted to using a Vector Autoregression (VAR) method.

Figure (1)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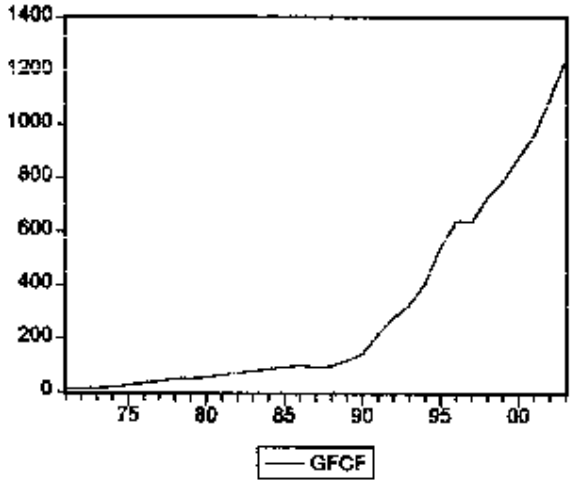
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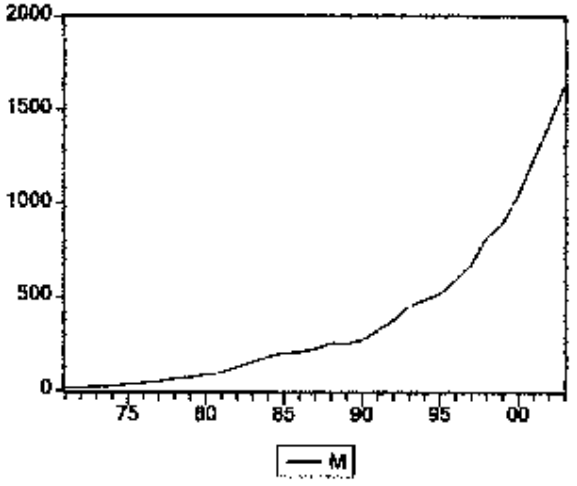
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Figure (2)

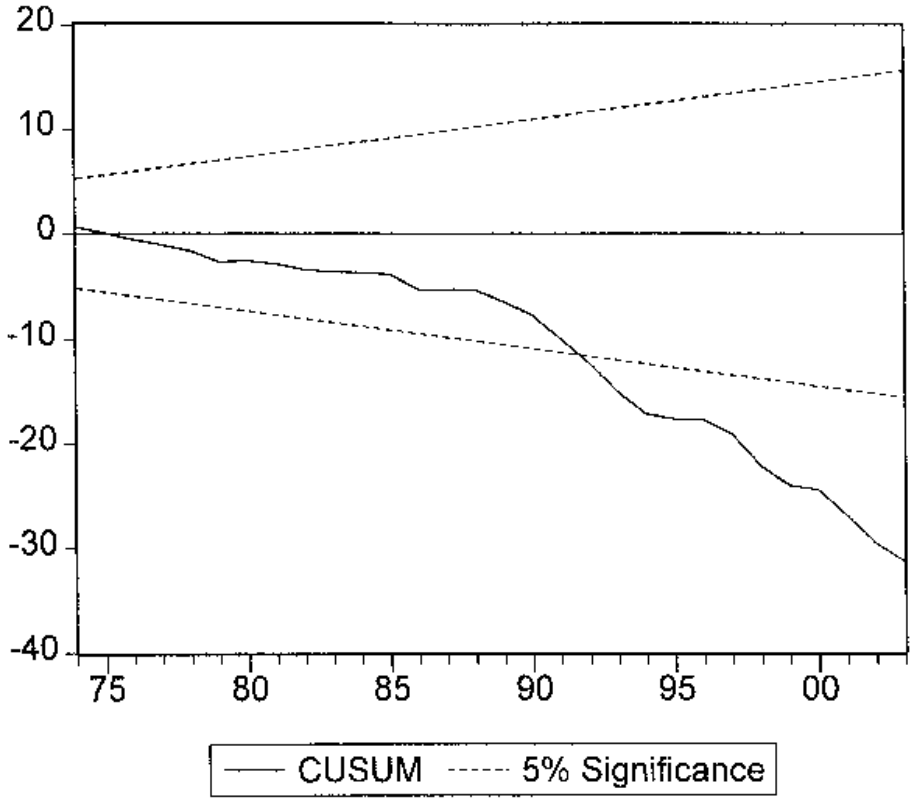
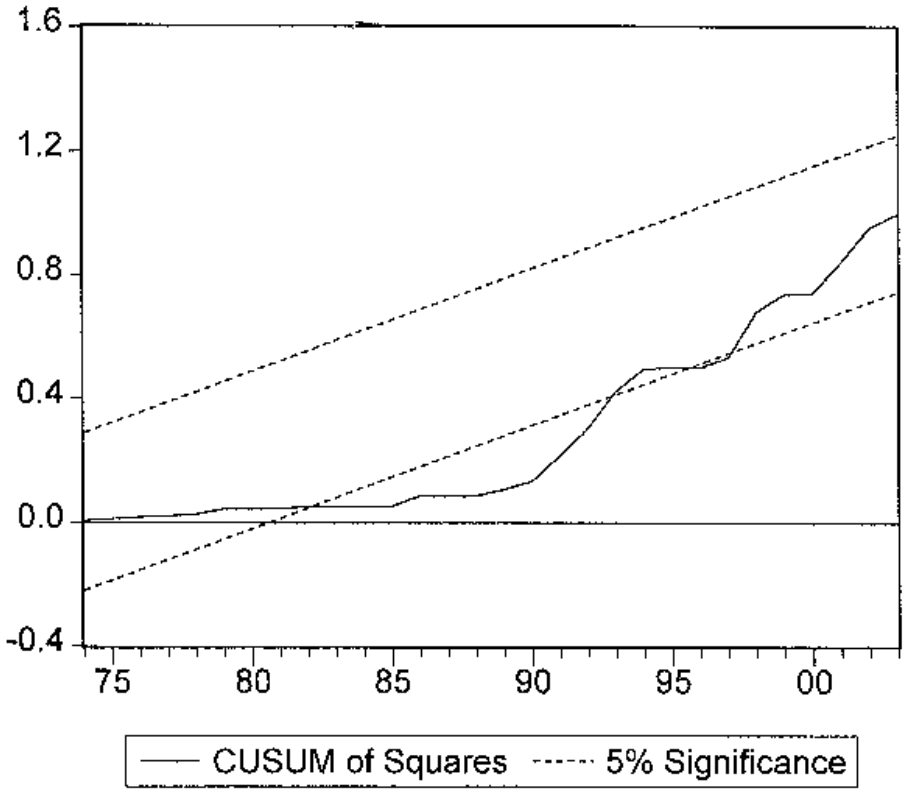


Figure (3)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CUSUM of Squares
5% Significance

Table (4) Results of the Augmented Dickey-Fuller (ADF) unit root testfor the period (1971-1989)

Variable	Number of Lags	Durbin-Watson (D-W)	Calculated ADF value	5% Critical Value
RGDP	0	2.10	-2.072	-3.040
GFCF	0	1.79	0.292	-3.040
M	3	1.93	-0.878	-3.082
Δ(RGDP)	0	1.95	-3.59	-3.052
Δ(GFCF)	0	1.79	-3.48	-3.052
Δ(M)	3	1.90	-1.65	-3.100
Δ(M,2)	3	1.86	-3.698	-3.066

Notes: - RGDP denotes the real Gross Domestic Product.
- GFCF denotes the gross fixed capital formation.
- M denotes money supply (M1).
- Δ(RGDP) denotes the first difference of RGDP.
- Δ(GFCF) denotes the first difference of GFCF.
- Δ(M) denotes the first difference of M.
- Δ(M,2) denotes the second difference of M.
-The number of lags is chosen to ensure the nonexistence of serial autocorrelation.

Table (5) Results of the Augmented Dickey-Fuller (ADF) unit root test for the period (1990-2003)

Variable	Number of Lags	Durbin-Watson (D-W)	Calculated ADF value	5% Critical Value
RGDP	2	1.93	0.559	-3.100
GFCF	0	1.90	2.052	-3.100
M	2	2.30	3.056	-3.100
Δ(RGDP)	1	1.79	-3.360	-3.100
Δ(GFCF)	0	1.99	-2.350	-3.100
Δ(GFCF,2)	0	2.23	-5.030	-3.100
Δ(M)	2	2.24	0.568	-3.100
Δ(M,2)	2	2.15	-3.870	-3.100

Notes: - RGDP denotes the real Gross Domestic Product.
- GFCF denotes the gross fixed capital formation.
- M denotes money supply (M1).
- Δ(RGDP) denotes the first difference of RGDP.
- Δ(GFCF) denotes the first difference of GFCF.
- Δ(GFCF,2) denotes the second difference of GFCF.
- Δ(M) denotes the first difference of M.
- Δ(M,2) denotes the second difference of M.
-The number of lags is chosen to ensure the nonexistence of serial autocorrelation.

The Vector Autoregression (VAR) Method:

In this method, we treat all the variables as endogenous, as there are no exogenous variables. The two major tools for this method of estimation are the variance decompositions and impulse response functions. The results of these two tools are as follow:

1. Variance Decomposition

While the Granger-causality test is important, a more formal statistical assessment could be obtained by computing variance decompositions for the variable under consideration at various horizons.

i) Variance decompositions of the RGDP variable for the period (1971-1989) are reported in table (6) below.

Table (6) Variance Decompositions of RGDP for the Period (1971-1989)

Period	RGDP	GFCF	M
1	100.00	00.00	00.00
2	86.19	3.31	10.50
3	76.57	3.67	19.76
4	80.73	5.38	13.89
5	83.42	9.80	6.78
6	79.80	12.68	7.52
7	76.51	13.50	9.99
8	78.01	13.97	8.03
9	79.76	14.94	5.30
10	78.43	16.23	5.34

Notes: - RGDP denotes the real Gross Domestic Product.
- GFCF denotes the Gross Fixed Capital Formation.
- M denotes the money supply (M1)

The figures in table (6) show that money supply explains more than the GFCF of the RGDP forecast error for the first four periods ahead, and this explanatory power starts to decline after four years. On the other hand, the GFCF has a higher predictive power than M in explaining the forecast error of RGDP in a longer period of time, where the predictive power of GFCF starts to be 9.80% for five years ahead, and increases until it reaches 16.23% for ten years ahead.

ii) Variance decompositions of the RGDP variable for the period (1990-2003) are reported in table (7) below.

Table (7) Variance Decompositions of RGDP for the Period (1990-2003)

Period	RGDP	GFCF	M
1	100.00	00.00	00.00
2	62.29	28.19	9.53
3	30.98	64.29	4.73
4	24.94	67.06	8.00
5	23.01	63.70	13.29
6	21.87	59.45	18.68
7	21.44	55.27	23.29
8	21.81	51.32	26.88
9	22.68	47.41	29.92
10	23.71	43.44	32.85

Notes: - RGDP denotes the real Gross Domestic Product.
- GFCF denotes the Gross Fixed Capital Formation.
- M denotes the money supply (M1).

The figures in table (7) show that GFCF has a greater effect on the RGDP than M for all time horizons for the period (1990-2003). The GFCF explains around 28% of the variations in the RGDP for two years ahead, and around 67% for four years ahead, and this explanatory power ends up to be around 43.4% for ten years ahead.

iii) Variance decompositions of the RGDP variable for the period (1971-2003) are reported in table (8) below.

Table (8) Variance Decompositions of RGDP for the Period (1971-2003)

Period	**RGDP**	**GFCF**	**M**
1	100.00	00.00	00.00
2	61.86	22.34	15.80
3	41.08	47.16	11.76
4	37.20	53.88	8.92
5	38.15	54.21	7.63
6	39.96	53.10	6.94
7	41.89	51.32	6.79
8	43.91	48.86	7.23
9	45.91	45.85	8.24
10	47.83	42.40	9.77

Notes: - RGDP denotes the real Gross Domestic Product.
- GFCF denotes the Gross Fixed Capital Formation.
- M denotes the money supply (M1).

The results of table (8) for the 1971-2003 period support the results of the 1990-2003 subperiod, where it is found that GFCF has more predictive power than M in explaining the variations of the RGDP level.

2. Impulse Response Analysis:

Having shown the variance decompositions of the RGDP variable in the model, the next step is to analyze the impulse responses. The impulse response function shows the

response of one variable to an impulse of another in a system that involves a number of other variables as well. If there is a reaction of one variable to an impulse of another variable, we may call the latter causal for the former (Lutkepohl, 1991, p 43). Thus the response function traces the response of an endogenous variable in the VAR system to unexpected shocks in the error terms of the variables in the system for several periods in the future (Gujarati, 1995, p 749). In other words, the impulse response function that is calculated by:

$$\frac{dY_{t+s}}{du_{jt}}$$ **, Y_t and u_t as defined in equation (1) above.**

measures the effect of a shock in the jth variable on future values of each of the variables in the system (Hamilton, 1994, p 327). Even though the use of the impulse response function has been questioned by researchers, it is a centerpiece of the VAR analysis (Runkle, 1987).

The impulse responses with upper and lower two standard deviation bands around the point estimates for the VAR model of this study are shown in figures (4), (5), and (6) for the periods (1971-1989), (1990-2003), and (1971-2003), respectively. The analysis of the results of the impulse responses can be summarized for the three periods of time as follows:

Figure (4)
Period (1971-1989)

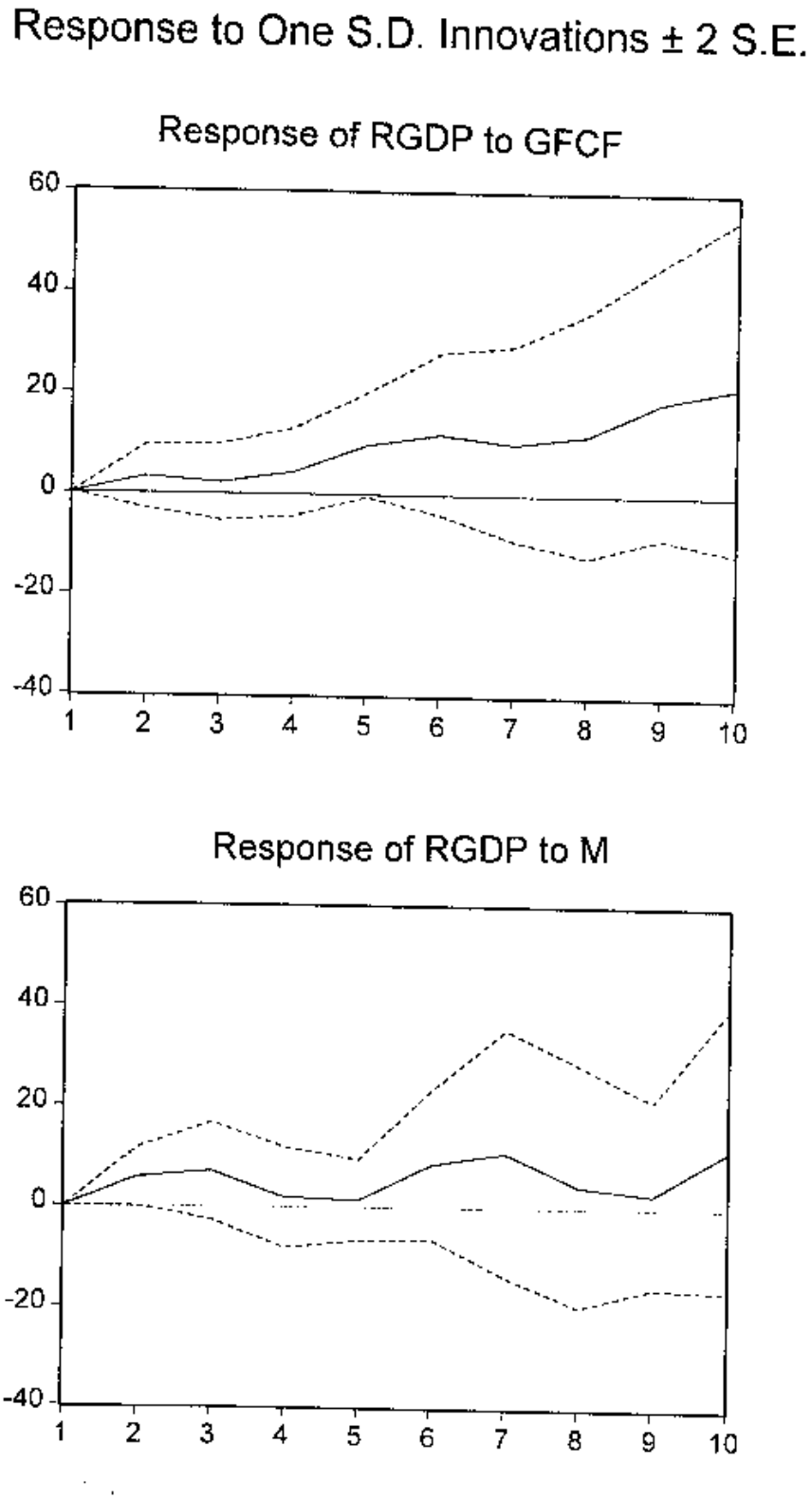


Figure (5)
Period (1990-2003)

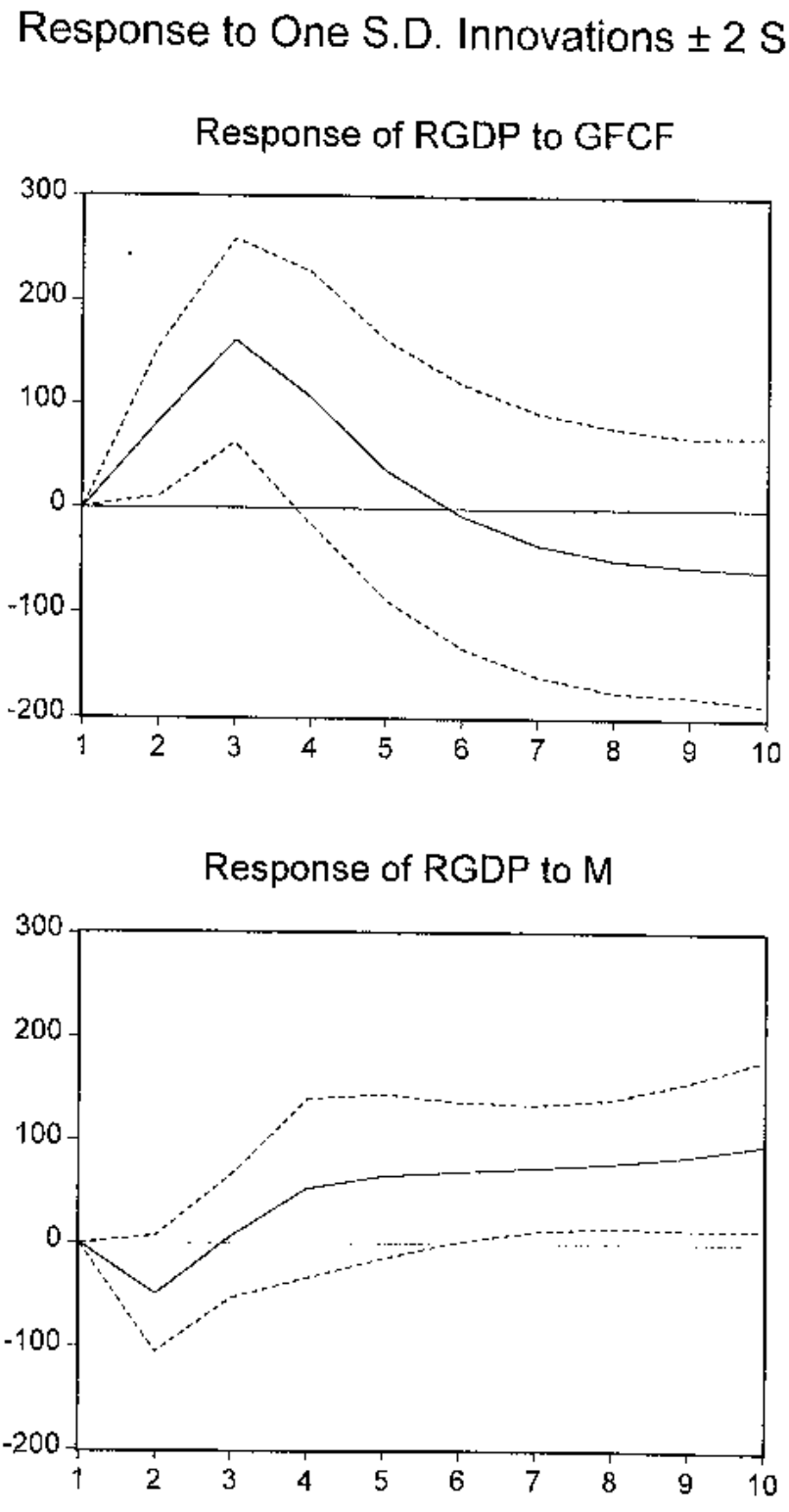
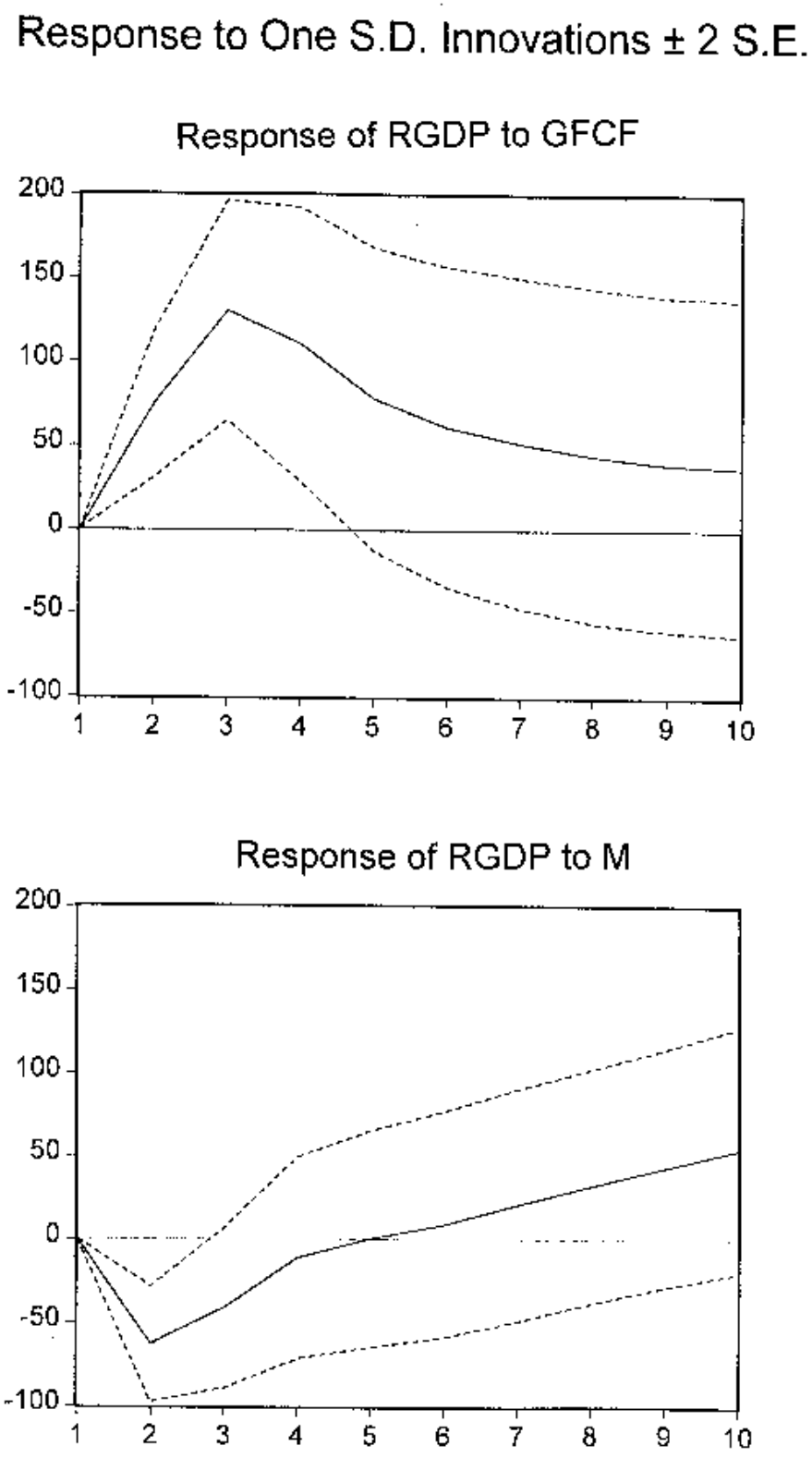


Figure (6)
Period (1971-2003)



i) Impulse response of the RGDP variable for the period (1971-1989):

Figure (4) shows that GFCF has a positive effect on RGDP over time, and this effect is marginally significant. On the other hand, the effect of M on RGDP is insignificant.

ii) Impulse response of the RGDP variable for the period (1990-2003):

Figure (5) shows that the GFCF disturbances have a hump-shaped effect on RGDP. This effect peaks after three years and starts to decline after that. On the other hand, the effect of M on RGDP starts to be negative and insignificant for the first three years and then reverses to positive and significant after five years.

iii) Impulse response of the RGDP variable for the period (1971-2003):

Figure (6) shows that GFCF still has a positive and stronger effect on RGDP than M. It is very important to note that the results of the 1971-2003 period are very similar to the results of 1990-2003 subperiod. These results are very consistent with Malawi's results (2006) for Jordan.

Conclusions and Recommendations:

This study has aimed to analyze the impact of Gross Fixed Capital Formation (GFCF) and money supply (M) on the real Gross Domestic Product (RGDP) in Algeria for the 1971-2003 period.

This study has employed different tools to test the results, such as Granger-causality, variance decompositions, and impulse response functions.

The results have, in general, found that GFCF has a strong effect on RGDP. This implies that the Government in Algeria should focus on the level of investment rather than on monetary policy to stimulate economic growth.

While I think this simple work is worthwhile, I also do believe that more future work is needed. I have in mind some specific extensions. Firstly, applying the model to quarterly or monthly data to get more accurate results. Secondly, considering adding new variables to the mode,l such as the fiscal policy in Algeria. And finally, applying the model to the growth rates of the variables in the model instead of their levels.

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