Money and Inflation Dynamics: A Lag between Change in Money Supply and the Corresponding Inflation Response in Tanzania

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Abstract

The price of money is "the goods and services" it can buy, which means, if money is plenteous will chase fewer or less amount of goods and services than it could actually do. Under normal conditions, money-inflation relationship is not instantaneous and so we should not expect all outcomes of currently implemented monetary policy actions to happen in the same current period. What is not clearly known for Tanzania is the time it takes a change in money supply to start impacting on inflation. The main objective of this paper is therefore to determine this time lag. Seasonally adjusted monthly data for the period 1994-2006 are used in the analysis and a GARCH model is applied in investigating inflation-money relationship. Estimation results indicate that a current change in money supply would affect inflation rate significantly in the seventh month ahead. They show further that the impact of money supply on inflation is not a sort of one-time strike on inflation but a kind of persistent shock. The main policy implication is that if we want to influence inflation in a certain future month, then we should take a policy action seven months before the targeted period. On the other side, if we want to evaluate the effectiveness of a monetary policy action taken in any previous month, we have to assess it in the seventh month ahead.

[1] All the views, ideas, approaches and conclusions made in this paper are solely that of the author only. Nothing is done on behalf of any institution, whatsoever, not even of my employer. Nonetheless, I appreciate with a lot of thanks the comments I got from my colleagues whom I don't mention by names, but indeed, made my writing a success.

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1.0 Introduction

It is attested in economics that the more bountiful a commodity the lower will be its price. The price of money is "the goods and services" it can buy, which means if money is plentiful will chase fewer or less amount of goods and services than it could actually do. Given the available quantity of goods and services in the economy, an increase in money supply will raise the general price level. According to theories of inflation, this trait is popularised by monetarists. Their contention is - money is the core source of inflation, and should there be some other cause factors, are of less importance. The Bank of Tanzania targets monetary growth in line with anticipated developments in annual growth rates of output and inflation.

Over the past one decade inflation in Tanzania has fallen. Inflation declined from 15.5 percent in December 1996 to 5.5 percent in December 2000; nonetheless, it rose to 6.7 percent in December 2006. Developments in money supply (M2 and M3)[2] during December 1996-December 2000 show a fairly rising trend with respective average increases in annual growth rates by 12.2 percent and 13.9 percent. Between December 2000 and December 2006, the period in which inflation went to the higher side, money supply rose by the average annual growth rates of 20.5 percent and 23.0 percent, respectively.

It is imperative to ascertain the time it takes for a change in money supply to affect the general price level, more especially when we consider the effectiveness of monetary policy. In essence, this is the research concern since that time lag is not certainly known for the case of Tanzania. We should expect some effects of monetary policy actions implemented in the current period to actually have no outcomes in the same recent time but rather in some other subsequent period, except money-inflation relationship were instantaneous. Knowing the exact time lag between a change in money supply and its

[2] M2 is money supply broadly defined, which consists M1 (currency in circulation outside banks and demand deposits of Tanzanian residents in deposit money banks) plus time and saving deposits of Tanzanian residents in deposit money banks. M3 consists of M2 plus foreign currency deposits of Tanzanian residents in deposit money banks.

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inflation response will let us understand unerringly the right timing of the monetary policy action aimed at impacting certain future month's prices.

One of the stylised facts is that changes in money supply are basically a result of interactions of the banks and markets, and therefore, inflation is impacted by particular effects of high volatility and tranquillity in monetary outcomes (Walters 1974, Roberts 2006). The main objective of this paper is actually to determine the time lag between a change in money supply and the corresponding inflation rate response.

1.1 Some Experiences from the Literature

I want to present some literature which highlights the facts and findings from other studies on money-inflation relationship. Being that we are talking about Tanzania as one of the developing countries, we will be biased to looking more into studies done for developing economies.

The general theory has basic two traits: (i) inflation is a monetary phenomenon per se; and (ii) though money may have some influence on inflation, inflation is not significantly determined by changes in money supply. Whether money determines inflation significantly or just a little, the concern we want to address here is the time period it takes change in money supply to affect inflation. Ndung'u (1994), and Durevall and Ndung'u (1998) argue that money supply drives inflation in Kenya, but in the short-run. Although short and long run concepts in economics are somewhat ambiguous, we have usually taken periods that are less than (or at most) one year as being short terms. Whether money supply affects inflation in the short-run or long-run, will depend on actual causes of inflation and the kind of money-to-inflation transmission mechanisms that are in the economy. If for example, a change in money supply first impacts interest rates, then output and eventually prices, this channel would take a longer transmission period than if a change in money supply directly affects aggregate demand and then prices.

In another study on monetary growth and exchange rate depreciation, Canetti and Greene (1992) found that money supply variations contribute little to variance of inflation in

Tanzania, Kenya, Zambia, Zaire and Ghana. In addition to that, the lag lengths in vector autoregressions (VARs) were proved to be short for these countries. Looking at money as a dominant variable in inflation determination, the case of Tanzania indicates that most of the impact occurs initially. There are reasons identified in the literature for the short lags and these comprise the nature of sources of inflation in most of African countries. Among such factors are the short-term climatic variations which affect consumer price index significantly through food prices. Nevertheless, for some few countries in the region including Sierra Leone and Uganda, their inflation variances were found to be significantly determined by changes in money supply. It worthy noting that for most of the western countries, money supply-inflation lag is usually estimated to be between 18 and 36 months.

If inflation is hyper, it is possible to have contemporaneous relationship between changes in money supply and inflation. Congolese data for 1990s indicate that feedback between inflation and money supply changes could be interpreted as a validation of the claim that the Congolese monetary authority allowed money supply to respond passively to demand; and so inflation causing monetary growth (Maswana 2005). The impression we get here is that depending on how closely money supply growth aligns to the rate of inflation, the lag between a change in money supply and inflation may be short or long. If they have self accentuation and each one of them derives the other, the time lag will be shorter than otherwise.

About Albania, a small open economy, there is a study (Dominiç and Elbirt 1998) which shows that the impact of exchange rate on inflation occurs quite rapidly. That is estimated to be after a month, but in that country influence of money on inflation was within four months lag. The study concludes that the money-inflation lag length was consistent with the results of other studies of Albania.

In our case, seasonally adjusted monthly data for the period 1994-2006 are used in the analysis. A simple autoregressive conditional variance heteroskedastic model is applied in investigating inflation-money relationship. A kind of general to specific estimation

technique is utilised and the results indicate that money supply impacts inflation starting from the third month, but it is strongly significant at the seventh month. The implication is that we should take monetary policy action targeted to affect inflation in some future month, not later than seven months before the targeted period. Note that M2 is found to have a stronger link with inflation than M3, and thus the lag presented here is specifically for M2.

2.0 Methodology and Estimations

2.1 Methodology

There are several analytical models that one can use to determine significance of lagged values of volatile explanatory variables[3] on a dynamic endogenous variable. These include inter alia, the application of stochastic macroeconomic models. Among the most commonly used methodologies are vector autoregressive frameworks, i.e. impulse response analysis, distributed lag models, and autoregressive conditional heteroskedastic (ARCH) models. For the purpose of this study, we resort to an application of the generalised autoregressive conditional heteroskedastic (GARCH) framework. This is a model borrowed from financial econometrics where it has been extensively used in analyses of stock return volatilities (Gazda and Vỳrost 2003). Some studies of exchange rate and inflation have also applied analytical tools from the family of ARCH models (Stančík 2006, Engle 1982).

The main reasons for selection of GARCH specification are: (i) variables we are using evolve primarily from transactions in financial markets, hence the assumption of residuals' constant variance may be simplistic because monetary and financial statistics are inherently heteroskedastic; (ii) unlike ARCH, a GARCH specification allows the conditional variance to be an ARMA process with assumption that, an increase (or a decrease) in exogenous variable will raise volatility of dependent variable in the

[3] Including the lagged values of the dependent variable.

subsequent period[4]; and (iii) the two-variable time series specification like the one we are going to use[5], needs a better fit than may be indicated by the traditional R-squired criterion which banks a lot on the number of included exogenous variables. From GARCH formulation we can also deduce persistence of the effect of a shock on dependent variable.

We will make use of the modified Engle (1982) ARCH specification which is generalised to GARCH by Bollerslev (1986). Maximum likehood estimation procedure will be used to determine lags' significance. For further extensions of ARCH models, you can read Zakoian (1994); and Glosten, Jaganathan, and Runkle (1993). To ensure efficient estimators, we need to model the variance of inflation variable as a function of past values of money supply. A general GARCH(P, Q) model is here written as

$$r = \alpha_0 + \sum_{i=1}^{P} \alpha_i m_{t-i} + \sum_{i=1}^{Q} \beta_i \varepsilon_{t-i} + \varepsilon_t; \quad \varepsilon_t \sim N(0, \sigma_t^2) \tag{1}$$

$$\sigma_t^2 = \xi + \sum_{i=1}^{p} \delta_i \varepsilon_{t-1}^2 + \sum_{i=1}^{q} \tau_i \sigma_{t-1}^2 \ . \tag{2}$$

Equation (1) is referred to as a mean equation, presenting inflation rate (r) which is explained by money supply (m), previous error realisations (ε_{t-1}), and a current random variable (ε_t). The second equation presents conditional variance (σ_t^2), which is a function of the previous realisations of error term and a last period's forecast variance (σ_{t-1}^2). The necessary and sufficient condition for stability of the conditional variance is the restriction $\sum_{i=1}^{p} \delta_i + \sum_{i=1}^{q} \tau_i < 1$.

Most of the estimated GARCH models are of order one, that is GARCH(1, 1), however, it does not rule out the possibility for the presence of the higher order GARCH specifications. In our case, we are not interested in looking at how changes in money

[4] The effects are assumed to be symmetric, i.e. whether a shock is positive or negative will have the same magnitude in terms of volatility/fluctuation in inflation rate. It may be a rise or fall; however, as of now there is no reason for expectation that after a negative shock on money supply there will be a higher fluctuation in inflation rate than after a positive shock; or the vice versa.

[5] Taking into account only interactions between money supply and inflation.

supply (cumulatively) over some past periods affect the current *r*, but rather in how each respective lag of money supply has been significant on the realised *r*. In this regard, we should estimate an order one GARCH of *r* at time *t* against respective lagged values of *m* for the periods 1 to *P*. An appropriate specification therefore modifies equations (1) and (2) to a logarithmic GARCH(1, 1) for the current inflation rate as a function of the *i*th lag of money supply. Here written with *l* denoting log;

$$lr_t = \alpha_0 + \alpha_1 lm(-i) + \varepsilon_t;\ \ \varepsilon_t \sim N(0, \sigma_t^2),\ \ i = 1, 2, \ldots., \mathrm{P} \qquad (3)$$

$$\sigma_t^2 = \xi + \delta_1 \varepsilon_{-i}^2 + \tau_1 \sigma_{-i}^2\ . \qquad (4)$$

The mean equation (3) is a function of the lag of exogenous variable and an error term; while conditional variance of the period ahead is stated as a function of the mean (ξ), the news about volatility from previous period measured by the lag of squared residuals (i.e. ARCH term), and the previous period's forecast variance (i.e. GARCH term). To reach the specific significant lag, we resort to estimation of a distributed lag model, which reduces from general to specific form.

In the analysis we are going to use seasonally adjusted monthly data for the period, June 1994-December 2006. These series are in high frequency, with reliable data and are long enough to provide reasonable statistical relationships.

2.2 Estimations

A set of equations (3) and (4) is estimated after some preliminary investigation of the properties of the data. Monetary aggregates (*m*) considered are M2 and M3. In the first step we start by observing statistical properties of M2, M3 and inflation rate. Unit roots on inflation and money supply are tested using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) techniques. See the results on Table 1 below.

Table 1: Unit Root Tests on Inflation and Money Supply

	ADF Test Statistic	ADF Test - Critical Values		
		1%	5%	10%
M2 - level	0.622	-3.476	-2.881	-2.577
M2 - 1st difference	-5.277	-3.476	-2.881	-2.577
M3 - level	1.074	-3.476	-2.881	-2.577
M3 - 1st difference	-5.765	-3.476	-2.881	-2.577
Inflation - level	-2.413	-3.476	-2.881	-2.577
Inflation - 1st difference	-5.120	-3.476	-2.881	-2.577
	PP Test Statistic	**PP Test - Critical Values**		
		1%	5%	10%
M2 - level	0.151	-3.475	-2.881	-2.577
M2 - 1st difference	-12.816	-3.475	-2.881	-2.577
M3 - level	0.714	-3.475	-2.881	-2.577
M3 - 1st difference	-12.472	-3.475	-2.881	-2.577
Inflation - level	-2.285	-3.475	-2.881	-2.577
Inflation - 1st difference	-9.385	-3.475	-2.881	-2.577

Inflation and money supply are integrated of order one as indicated by both ADF and PP tests. Being of the same order of integration, we can now check the long-run relationship between the variables, which is done by undertaking cointegration analysis and establishing whether inflation and money supply evolve according to the existing theoretical underpinnings (equations 5 and 6)[6].

$$r = -1044.6 + 74.9M2 \qquad (5)$$
$$(2104.1)$$
Log likelihood 614.8

$$r = 154.3 - 11.0M3 \qquad (6)$$
$$(67.2)$$
Log likelihood 617.3

These are respective cointegrating equations for M2 and M3. Because money supply and inflation are related in a lagged kind of relationship, magnitudes and significances of coefficients of long-run equations may not be that important, but the lon-run equation should at least reveal the hypothesised theoretical links. Given M2 and M3 equations, the equation (5), which is a long-run fitted function for M2 supports monetarist thought that a rise in money supply leads to an increase in inflation rate. Equation (6), which is a long-run fitted function for M3 does not support a positive relationship between inflation and

[6] Since both inflation and money supply are I(1), we can examine whether they wander together, i.e. if there is any kind of properly theorised relationship in their movement over a long time.

money supply. Instead, it postulates inverse relationship between the variables. By the virtue of these results, we are going to use M2 as the working variable in testing significance of the respective lags of money supply on inflation rate.

We start by estimating a function with distributed lags to observe their significance in general (Table 2), and then we narrow down to specific lags indicating strong correlation.

Table 2: Estimates of the General Model of Inflation and Lagged Money Supply
(Dependent Variable is DLr. D denotes diference & L denotes log)

	Coefficient	**Std. Error**	**z-Statistic**	**Prob.**
C	-0.075	0.023	-3.273	0.001
DLM2(-1)	0.316	0.426	0.741	0.458
DLM2(-2)	0.033	0.442	0.075	0.940
DLM2(-3)	0.545	0.370	1.473	0.141
DLM2(-4)	0.457	0.430	1.063	0.288
DLM2(-5)	0.128	0.386	0.331	0.740
DLM2(-6)	0.307	0.415	0.738	0.460
DLM2(-7)	0.832	0.414	2.010	0.044
DLM2(-8)	0.285	0.352	0.810	0.418
DLM2(-9)	-0.189	0.384	-0.492	0.622
DLM2(-10)	-0.426	0.319	-1.337	0.181
DLM2(-11)	0.238	0.336	0.708	0.479
DLM2(-12)	0.201	0.422	0.476	0.634
DLM2(-13)	0.510	0.376	1.357	0.175
DLM2(-14)	0.320	0.427	0.750	0.453
DLM2(-15)	-0.410	0.326	-1.257	0.209
DLM2(-16)	-0.125	0.388	-0.322	0.747
DLM2(-17)	-0.284	0.333	-0.852	0.394
DLM2(-18)	0.467	0.324	1.443	0.149
DLM2(-19)	0.486	0.329	1.476	0.140
DLM2(-20)	0.366	0.316	1.159	0.246
DLM2(-21)	0.368	0.360	1.022	0.307
DLM2(-22)	0.177	0.357	0.495	0.620
DLM2(-23)	0.290	0.396	0.732	0.464
DLM2(-24)	0.104	0.366	0.285	0.775
Variance Equation				
C	0.0004	0.0002	2.0197	0.0434
ARCH(1)	-0.0678	0.0293	-2.3184	0.0204
GARCH(1)	0.8911	0.0810	11.0032	0.0000
R-squared	0.1845	Mean dependent var		-0.0097
Adjusted R-squared	-0.0402	S.D. dependent var		0.0612
S.E. of regression	0.0624	Akaike info criterion		-2.6993
Sum squared resid	0.3821	Schwarz criterion		-2.0690
Log likelihood	198.05	Durbin-Watson stat		1.5312

To estimate this distributed lag model, we first begin with the assumption that a change in money supply could take up to two-year period to reflect on prices. Based on this assumption we estimate a GARCH model of twenty-four lags of money supply.

Observations from Table 2 are: (i) there is one significant lag of money supply, M2(-7); pseudo R-squared is low but this is not a problem with ARCH models; and from this version we get just a clue that M2(-7) may be the significant lag. What we do now is to move to the specific significant lag by reducing the model step by step through elimination of the least significant lags each round. This process can be viewed in the appendix tables. Here Tables 3 and 4 present the most parsimonious last two equations and these tell us that M2(-7) is the most significant lag.

Table 3: Estimates of Reduced Form Model of Inflation and Lagged Money Supply

	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.0294	0.0081	-3.6420	0.0003
DLM2(-3)	0.5684	0.2966	1.9164	0.0553
DLM2(-7)	0.7479	0.2981	2.5088	0.0121
	Variance Equation			
C	0.0008	0.0009	0.9775	0.3283
ARCH(1)	0.0170	0.0341	0.4977	0.6187
GARCH(1)	0.7158	0.2826	2.5331	0.0113
R-squared	0.0652	Mean dependent var		-0.0119
Adjusted R-squared	0.0311	S.D. dependent var		0.0602
S.E. of regression	0.0592	Akaike info criterion		-2.7997
Sum squared resid	0.4803	Schwarz criterion		-2.6754
Log likelihood	206.182	F-statistic		1.9104
Durbin-Watson stat	1.5282	Prob(F-statistic)		0.0965

Observations: a seventh lag is significant (at 5 percent level) and a third lag is weakly significant (at 10 percent level) in this model. GARCH term is significant and high, which means the effect of a change in money supply on inflation persists for some time. We can further eliminate the weak lag to see if there is more strength in explanatory power of the seventh lag (Table 4). The only risk we run here is - this may distort the overall goodness of fit as we trim down the number of regressors to one, but even so we can still make some reasonable conclusions by reducing it further.

If we would take these results as our final estimates, then we could say that in the third month after money supply changes, its impact on inflation starts to be realised, however, a clearly significant impact is witnessed in the seventh month later. The implication is that although a considerable impact is estimated at the seventh lag, some inflation responses happen in much earlier periods than seven months, in this case, just after three months.

Table 4: Estimates of Reduced Form Model of Inflation and Seventh Lag of Money Supply

	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.0227	0.0065	-3.4994	0.0005
DLM2(-7)	0.7566	0.2743	2.7584	0.0058
	Variance Equation			
C	0.0008	0.0009	0.9710	0.3316
ARCH(1)	0.0578	0.0646	0.8954	0.3706
GARCH(1)	0.6885	0.3041	2.2642	0.0236
R-squared	0.0374	Mean dependent var		-0.0119
Adjusted R-squared	0.0095	S.D. dependent var		0.0602
S.E. of regression	0.0599	Akaike info criterion		-2.7867
Sum squared resid	0.4946	Schwarz criterion		-2.6831
Log likelihood	204.25	F-statistic		1.3399
Durbin-Watson stat	1.5092	Prob(F-statistic)		0.2583

Observations: With this specification, seventh lag of M2 is significant at 1 percent level. GARCH term is significant and still high (with coefficient of 0.7) showing that volatility in money supply would cause some persistent impact on prices. If you remove M2(-7) from preceding equation instead of M2(-3), and then estimate the model, you continue to get a weak significance of the third lag. Therefore estimations of these models provide us with evidence that a change in money supply would impact on inflation significantly in the seventh month ahead.

Before we make firm conclusions from the foregoing estimates we are supposed to do some post estimation tests of the distribution of error term of the last parsimonious model, and also to test whether there are more ARCH in the model. Table 5 shows residuals normality test.

Table 5: Jarque-Bera Residuals Normality Test

(*Standardized residuals*)	
Mean	0.0066
Median	0.0417
Maximum	3.7802
Minimum	-3.6191
Std. Dev.	1.0073
Skewness	-0.4473
Kurtosis	6.3716
Jarque-Bera Stat.	72.499
Probability	0.0000

A tested null hypothesis is - residual series is not normally distributed. The results reject this hypothesis outright and so residuals are normal. The other important examination is ARCH-LM test to check if there are more ARCHs in the residuals (Table 6). A tested null hypothesis is - there is no ARCH in residuals. Results accept this null hypothesis and so the specified model provides us with reliable estimates.

Table 6: Estimates of ARCH-LM Test of Residuals

F-statistic	0.2372	Probability	0.6270
Obs*R-squared	0.2402	Probability	0.6240

Dependent Variable: STD_RESID^2

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	1.0483	0.2150165	4.8755747	0.0000
STD_RESID^2(-1)	-0.0412	0.0844949	-0.4870800	0.6270
R-squared	0.0017	Mean dependent var		1.0071
Adjusted R-squared	-0.0054	S.D. dependent var		2.3493
S.E. of regression	2.3557	Akaike info criterion		4.5656
Sum squared resid	776.92	Schwarz criterion		4.6072
Log likelihood	-322.15	F-statistic		0.2372
Durbin-Watson stat	1.9991	Prob(F-statistic)		0.6270

You may also want to see the appended Table A4 of correlogram - Q-statistic.

3.0 Concluding Remarks

This paper aimed at identifying a time lag between a change in money supply and the inflation rate response. It approaches this problem by trying to estimate the significant lag of money supply (M2) which is proved to have a higher explanatory power on inflation than M3. A modified GARCH model is employed and estimated using monthly data for

the period 1994-2006. Maximum likelihood estimation technique is used in the analysis. The results indicate that a change in money supply would affect inflation rate considerably in the seventh month ahead. They show further that the impact of money supply on inflation is not a sort of one time strike on inflation but a kind of persistent shock. It worth noting that, there is also some evidence that after three months since the money supply changed there was at least a weak impact on inflation rate. Nevertheless, the major policy implication is - if we want to influence inflation in a certain future month, then we should take a policy action not later than seven months before the targeted period. On the other side, if we want to evaluate the effectiveness of a monetary policy action taken in any previous month, we have to gauge it at the seventh month ahead (i.e. after implementation).

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Appendix Tables

Table A1: Estimates of the First Reduced Form Version of the Model

(Dependent variable is DLr. D denotes difference & L denotes log)

	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.0735	0.0180	-4.0760	0.0000
DLM2(-1)	0.3206	0.4112	0.7796	0.4357
DLM2(-3)	0.5017	0.3298	1.5211	0.1282
DLM2(-4)	0.6033	0.3776	1.5979	0.1101
DLM2(-6)	0.3327	0.3812	0.8726	0.3829
DLM2(-7)	0.8369	0.3648	2.2941	0.0218
DLM2(-8)	0.1769	0.2883	0.6136	0.5395
DLM2(-10)	-0.4636	0.2699	-1.7181	0.0858
DLM2(-11)	0.4045	0.2967	1.3635	0.1727
DLM2(-13)	0.4792	0.3941	1.2161	0.2239
DLM2(-14)	0.3500	0.3256	1.0747	0.2825
DLM2(-15)	-0.2749	0.2881	-0.9543	0.3399
DLM2(-17)	-0.3852	0.2550	-1.5105	0.1309
DLM2(-18)	0.4120	0.2902	1.4196	0.1557
DLM2(-19)	0.4906	0.3383	1.4499	0.1471
DLM2(-20)	0.4969	0.3053	1.6280	0.1035
DLM2(-21)	0.2711	0.3308	0.8197	0.4124
DLM2(-32)	0.2458	0.3967	0.6195	0.5356
Variance Equation				
C	0.0004	0.0001	2.8272	0.0047
ARCH(1)	-0.0785	0.0192	-4.0834	0.0000
GARCH(1)	0.9337	0.0469	19.9096	0.0000
R-squared	0.1784	Mean dependent var		-0.0098
Adjusted R-squared	0.0234	S.D. dependent var		0.0610
S.E. of regression	0.0603	Akaike info criterion		-2.7895
Sum squared resid	0.3851	Schwarz criterion		-2.3192
Log likelihood	198.13	F-statistic		1.1507
Durbin-Watson stat	1.6456	Prob(F-statistic)		0.3121

Table A2: Estimates of the Second Reduced Form Version of the Model

	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.0628	0.0203	-3.0946	0.0020
DLM2(-1)	0.2410	0.4222	0.5708	0.5681
DLM2(-3)	0.7709	0.3539	2.1781	0.0294
DLM2(-4)	0.5031	0.3496	1.4390	0.1502
DLM2(-6)	0.2259	0.3951	0.5716	0.5676
DLM2(-7)	1.0680	0.3578	2.9849	0.0028
DLM2(-10)	-0.3068	0.3481	-0.8815	0.3781
DLM2(-11)	0.2102	0.3098	0.6785	0.4975
DLM2(-13)	0.4839	0.3392	1.4268	0.1536
DLM2(-14)	0.2729	0.3583	0.7616	0.4463
DLM2(-15)	-0.5366	0.3063	-1.7521	0.0798
DLM2(-17)	-0.3168	0.3002	-1.0551	0.2914
DLM2(-18)	0.3448	0.3920	0.8795	0.3791
DLM2(-19)	0.3816	0.3775	1.0110	0.3120
DLM2(-20)	0.2362	0.3952	0.5977	0.5500
DLM2(-21)	0.1752	0.3852	0.4549	0.6492
Variance Equation				
C	0.0026	0.0035	0.7431	0.4574
ARCH(1)	-0.0794	0.0136	-5.8498	0.0000
GARCH(1)	0.1837	1.1946	0.1538	0.8778
R-squared	0.2016	Mean dependent var		-0.0104
Adjusted R-squared	0.0709	S.D. dependent var		0.0607
S.E. of regression	0.0585	Akaike info criterion		-2.7724
Sum squared resid	0.3768	Schwarz criterion		-2.3512
Log likelihood	197.82	F-statistic		1.5430
Durbin-Watson stat	1.6243	Prob(F-statistic)		0.0887

Table A3: Estimates of the Third Reduced Form Version of the Model

	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.0297	0.0116	-2.5632	0.0104
DLM2(-3)	0.5886	0.3044	1.9334	0.0532
DLM2(-4)	0.4566	0.3217	1.4192	0.1558
DLM2(-7)	0.8950	0.3510	2.5500	0.0108
DLM2(-13)	0.3140	0.3336	0.9412	0.3466
DLM2(-15)	-0.4999	0.2682	-1.8637	0.0624
DLM2(-17)	-0.3136	0.2546	-1.2317	0.2181
	Variance Equation			
C	0.0025	0.0022	1.1171	0.2639
ARCH(1)	-0.0632	0.0346	-1.8296	0.0673
GARCH(1)	0.2390	0.7276	0.3285	0.7425
R-squared	0.1609	Mean dependent var		-0.0105
Adjusted R-squared	0.0995	S.D. dependent var		0.0599
S.E. of regression	0.0568	Akaike info criterion		-2.8426
Sum squared resid	0.3972	Schwarz criterion		-2.6252
Log likelihood	199.03	F-statistic		2.6202
Durbin-Watson stat	1.5804	Prob(F-statistic)		0.0083

Table A4: Correlogram-Q-Statistic for the Final Parsimonious Equation

Lags	AC	PAC	Q-Stat	Prob
1	0.2179	0.2179	6.9306	0.0085
2	-0.0658	-0.1189	7.5673	0.0227
3	0.0185	0.0644	7.6181	0.0546
4	-0.0316	-0.0633	7.7673	0.1005
5	-0.0105	0.0207	7.7839	0.1686
6	-0.0031	-0.0167	7.7854	0.2543
7	0.0906	0.1065	9.0371	0.2500
8	-0.0443	-0.1051	9.3389	0.3145
9	0.1412	0.2206	12.4233	0.1905
10	0.1804	0.0656	17.4954	0.0641
11	-0.0066	-0.0156	17.5023	0.0939
12	-0.1846	-0.2028	22.8968	0.0286
13	-0.0656	0.0499	23.5831	0.0352
14	0.1138	0.0852	25.6651	0.0285
15	0.1295	0.1454	28.3806	0.0193
16	0.1756	0.0888	33.4175	0.0065
17	0.0015	-0.0635	33.4179	0.0100
18	0.0142	0.0436	33.4512	0.0147
19	0.0294	-0.0058	33.5953	0.0205
20	-0.0158	-0.0372	33.6372	0.0287
21	0.0267	0.0814	33.7585	0.0385
22	-0.0109	0.0303	33.7790	0.0517
23	0.0267	-0.0011	33.9023	0.0666
24	0.0360	-0.0481	34.1280	0.0824
25	0.2242	0.1786	42.9610	0.0141
26	0.0265	-0.0852	43.0851	0.0189
27	-0.1263	-0.0106	45.9380	0.0129
28	-0.0419	-0.0383	46.2538	0.0164
29	-0.0135	0.0093	46.2869	0.0220
30	0.0432	0.0021	46.6296	0.0270
31	0.0382	0.0285	46.9004	0.0334
32	0.1267	0.0476	49.8987	0.0228
33	0.0341	0.0505	50.1184	0.0285
34	0.0692	0.0386	51.0292	0.0305
35	0.0549	-0.0492	51.6083	0.0348
36	-0.0418	-0.0102	51.9470	0.0415