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Revisiting the quantity theory of money in Euro Area: the case of Greece

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Abstract

This study revisits the Quantity Theory of Money for Greece from the perspective of potentially nonlinear relations between the variables of the *equation of exchange*. Therefore, this methodological approach makes this study different from previous empirical studies, which were constructed on the assumption of linear relations in this equation. To this aim, for the first time, the nonlinear ARDL model is applied for testing the QTM for a specific country. This model decomposes the variables *money stock*, *price level*, and *income* in the *equation of exchange* into their increases and decreases. Therefore, the model enables us to examine the validity of the QTM through these increases and decreases separately (*partially*) under the nonlinear approach. The new methodological approach of this study may be interpreted as a new version of *partial* QTM testing in relevant literature. Empirical findings reveal that the QTM is partially and weakly valid for Greece. This may emerge not only from the structure of the Greek economy, the behavior of Greek people's financial priorities and the Bank of Greece's monetary policies, but also from the ECB's monetary policies and the behavior of the other euro area countries' people's financial priorities, since Greece is a euro area country.

JEL classification: E40, E41

Keywords: Quantity theory of money (QTM), Partial QTM testing, Greece, Euro area

1. Introduction

The history of the *The Quantity Theory of Money* (QTM) goes back to at least the 16th century. The French philosopher Jean Bodin (1568) first introduced his monetary theory of the price inflation that occurred in Western Europe caused by new monetary metal inflows from South America (Humphrey, 1974). Following Bodin this structural relationship between quantity of money and inflation has attracted the substantial attention of many economists, such as John Locke (1692), David Hume (1752), Milton Friedman (1968), Karl Brunner and Allen Meltzer (1963), and Ludwig von Mises (1912) with many revisions, as well as numerous cases of further elaboration, and extension between the 16th and the 20th centuries. Apart from these authors' contributions, which are beyond the scope of this study, the QTM, as a cornerstone of monetarism, is built on an equation, namely the *equation of exchange*, developed by Irving Fisher (1911). According to this equation,

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presented below, money stock multiplied by the velocity of money equals the nominal GDP.

$$M \, x \, V = P \, x \, R = Y \qquad (1)$$

In this equation, M is money stock, V is velocity of money, P is the average price level, and R is the real income ($PxR = Y$ denotes nominal income). In the purest and shortest form of the equation, both V and R are expected to be constant, at least in the short-run. Therefore, the QTM in this equation indicates that change in money stock (M) leads to *one-to-one (unitary)* proportional change in price level (P) in the long-run. Friedman (1963) postulates this relation with his famous dictum "*Inflation is always and everywhere a monetary phenomenon*". He succinctly and implicitly summarizes that there is a linear (positive) relation between money stock and prices (inflation) (Hetzel, 2007, p.16). According to this linear relation, while rises in money stock (exogenously by central banks) lead to increases in price level, drops lead to decreases. However, this relation (in practice), may be nonlinear (asymmetric). This means that while rises in money stock may lead to decreases in price level, drops may lead to increases. Another possibility is that, while rises in money stock may lead to increases in price level, drops may have no impacts in prices or vice versa. Although there are many studies which have investigated the relation between money stock and inflation (Friedman, 1963; Friedman and Swartz, 1963; King, 2002; Benati, 2009 among others), there is limited number of studies which investigate the asymmetry in pass-through from money stock to inflation (Bell and Mankiw, 1994; Crowder, 1998; Weise, 1999; Karras and Stokes, 1999; Senda, 2001; Amisano and Colavecchioz, 2013; Cooray and Khraief, 2018; Olayiwola and Ogun, 2019).

The rationale of using an asymmetric (nonlinear) approach in our model is that rising uncertainties in economies and *asymmetric information problem* can easily cause potential asymmetric (nonlinear) behaviors/results in financial markets such as adverse selections, moral hazards, incomplete markets and thereby market failures. Additionally, adaptive expectations, changing money demand motives (transaction, precautionary and speculative) and financial crises may increase these asymmetric (nonlinear) relations also between macroeconomic variables such as money stock and inflation. This means that all economic actors such as barrowers, lenders, financial intermediaries, and central banks may exhibit aymmetric behaviours potentially. Hence, all these may require also applying nonlinear (asymmetric) approaches in empirical models. The *Liquidity Trap* by Keynes (1936) is a good example for this potential nonlinear (asymmetric) relation between money stock and inflation. If increases in money demand are proportionally equal to increases in money stock, inflation may instead remain stable or increases in money demand are higher than increases in money stock, inflation may fall.

Therefore, this study revisits the QTM from this perspective of potentially asymmetric (nonlinear) relations and reexamines this theory for Greece. To this aim, for the first time, the nonlinear ARDL (Auto Regressive Distributed Lag) model is applied for testing the QTM for a specific country. This methodological approach makes this study different from previous empirical studies, which test the QTM on the assumption of linear (symmetric) relations for Greece or any other country. Few studies empirically examine the QTM for Greece. Karfakis (2002) applies the unit root and the ARDL approach to cointegration and tests two monetarist hypotheses, i.e., the predictability of income velocity of money and the proportionality between money stock and nominal income (or, prices). The author finds the validity of the QTM for this country. Ozmen (2003), in response to Karfakis (2002), applies the ARDL bounds and Johansen procedures and does not find the validity of the QTM for Greece. Karfakis (2004) again, in response to Ozmen (2003) applies the ARDL approach with the maximum lag at six in the VAR (vector autoregressive) system and re-affirms the exogeneity of money supporting the QTM for Greece.

Besides its new methodology, another departure point for this study is the sample period used and analyzed. Contrary to the studies mentioned above, this study tests the QTM for the post-period of Greece’s adoption (after March 2002) of the Euro. This adoption, as a game changer, required redefinition of the monetary aggregates for all *euro area*[1] countries, which caused some uncertainties concerning

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[1] Euro area consists of the European Union countries that have adopted the euro as their currency.

the real amounts of monetary aggregates in these countries. If it is because of these concerns scholars might have intentionally avoided testing the QTM for euro area countries including Greece. However, it is believed that the QTM may be tested for Greece (or for any other euro area country) by using newly defined monetary aggregates of this country, which is referred to as the "*Greek contribution*[2]" to the euro area aggregates. The *Greek contribution* is calculated in different manners and equals to: *(i)* the deposits held by Greek and other euro area countries' residents in Greek monetary financial institutes (MFIs); *(ii)* the banknotes put into circulation by the Bank of Greece (BoG); *(iii)* dept securities issued by Greek MFIs minus debt securities issued by all euro area MFIs. Therefore, the empirical results of this study should be considered-interpreted on the assumption that the series of the Greek M1 and M2, which were calculated on the basis of the "*Greek contribution*", can, to some degree, be accepted and used as monetary aggregates of Greece. "To some degree" means that the real amounts of currency in Greece can be higher than the amount of currency put in circulation by the *Greek contribution* (by BoG), since some amount of currencies can freely flow into Greece from other euro area countries (surpluses). On the other hand, the real amounts of currency in Greece can also be lower than the amount of currency put in circulation by the *Greek contribution,* since some can flow out to other euro area countries from Greece (deficits). However, these bilateral impacts (inflows-outflows) can counterbalance such surpluses-deficits and may enable us to use the *Greek contribution* as Greek aggregates. Furthermore, from another alternative perspective, the empirical results of this study can also be interpreted as indicating that the validity of the QTM for Greece is tested by both the *Greek contribution* (by BoG) and other euro area countries' *contributions* to the euro area aggregates jointly. Therefore, this study differs from three studies mentioned above because of its new methodology and because the sample period (post-adoption of the Euro) has never been examined for testing the QTM for Greece.

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[2] For technical instruction and detailed information, visit the websites of the Bank of Greece (https://www.bankofgreece.gr/en/statistics/monetary-and-banking-statistics/monetary-aggregates) and the European Central Bank (ECB) (https://www.ecb.europa.eu/euro/exchange/html/index.en.html)

This study is organized as follows. Section 2 explains the empirical model and methodology of the study. Sections 3 and 4 provide empirical findings and concluding remarks, respectively.

2. Empirical Model-Methodology

In order to test the QTM, the *equation of exchange* is used, which was presented as Eqn. 1. We rewrite Eqn. 1 in the following logarithmic form:

$$m_t + v_t = p_t + r_t = y_t \tag{2}$$

In Eqn. 2, lower-case letters are log variables. According to the QTM, each one of $m, p, r,$ or their linear combination with a coefficient vector (-1 1 1) is stationary (I(0)). Cointegrated *one-to-one (unitary)* proportional relations between m and y (or p and, r) require that v be stationary. However, this is a necessary but not sufficient condition for the validity of the QTM. The QTM also requires exogeneity of the money stock, which means that there must be no cointegrated relations from both y and p to m. Our sample period is 2002M03-2019M06.

For testing the QTM, we construct all the following alternative directional models derived from the model in Eqn. 2, under the assumption that v and r are to be constant:

$$p_t = \alpha_0 + \alpha_1 m_t + \varepsilon_t \tag{3}$$
$$y_t = \beta_0 + \beta_1 m_t + e_t \tag{4}$$

In Eqns. 3 and 4, we seek significantly cointegrated one-to-one proportional relations from $\mathrm{m_t}$ to $\mathrm{p_t}$, as well as from $\mathrm{m_t}$ to $\mathrm{y_t}$ for verification of the QTM ($\alpha_1 = \beta_1 = 1$). In regards to directional relations from y_t to m_t and p_t to m_t the following models are constructed in Eqns. 5 and 6, respectively.

$$m_t = \theta_0 + \theta_1 y_t + \epsilon_t \tag{5}$$

$$m_t = \delta_0 + \delta_1 p_t + \varepsilon_t \tag{6}$$

In Eqns. 5 and 6, we expect that there must not be cointegrated relations from y_t to m_t and p_t to m_t (or θ_1 and δ_1 must be insignificant). This will signify exogeneity of money stock.

The empirical methodology of this study is constructed on the nonlinear ARDL model by Shin et al. (2014). This model is the nonlinear version of the linear ARDL model by Pesaran et al. (2001). Therefore, we first provide the linear model for Eqns. 3, 4, 5 and 6 in the following sample form model (for the sake of simplicity and economy):

$$\Delta x_{1t} = a + b_1 x_{1t-1} + b_2 x_{2t-1} + \sum c_i \, \Delta x_{1t-i} + \sum d_j \, \Delta x_{2t-j} + \varepsilon_t \tag{7}$$

In this equation, Δ is the difference operator; x_{1t} and x_{2t} represent the dependent and independent variables, respectively, in Eqns. 3, 4, 5 and 6 for the linear model. After the linear model, we apply the nonlinear ARDL model. This model decomposes the series of independent variables (x_{2t}) into its increases (x_{2t}^{+}) and decreases (x_{2t}^{-}). Hence, it enables us to examine the impacts of these increases and decreases on the dependent variables (x_{1t}) separately. Therefore, using this model we may be able to test the validity of the QTM for increases (x_{2t}^{+}) and decreases (x_{2t}^{-}) separately (*partially*). This means that we will learn whether the effects of x_{2t}^{+} and x_{2t}^{-} on x_{1t} are symmetric or asymmetric. Symmetric effects are defined by the same size and same sign decomposed coefficients (x_{2t}^{+} and x_{2t}^{-}). However, the Wald test for short-run (W_{SR}) and long-run (W_{LR}) will formally lead us to symmetry or asymmetry decisions. The decomposition is constructed in the following partial sum process:

$$x_{2t}^{+} = \sum_{j=1}^{T} \Delta x_{2j}^{+} = \sum_{j=1}^{T} max\big(\Delta(x_{2j}, 0\big) \tag{8}$$

$$x_{2t}^{-} = \sum_{j=1}^{T} \Delta x_{2j}^{-} = \sum_{j=1}^{T} min\big(\Delta(x_{2j}, 0\big) \tag{9}$$

In this process, x_{2t}^{+} and x_{2t}^{-} show the partial sums of increases (+) and decreases (-) of x_{2t}, respectively. It should be noted that the concept of partiality in this study is based on separate individual impacts of x_{2t}^{+} and x_{2t}^{-} on x_{1t}. *After the decomposition process,* we obtain, as shown below, one sample form the nonlinear ARDL model with decomposed variables for Eqns.3, 4, 5 and 6.

$$\Delta x_{1t} = \beta_0 + \beta_1 x_{1t-1} + \beta_2 x_{2t-1}^{+} + \beta_3 x_{2t-1}^{-} + \sum \beta_{4i} \Delta x_{1t-i} + \sum \beta_{5j} \Delta x_{2t-j}^{+} + \sum \beta_{6j} \Delta x_{2t-j}^{-} + \varepsilon_t \tag{10}$$

In Eqn. 10 the short-run impacts of x_{2t}^{+} and x_{2t}^{-} on x_{1t} are determined by the signs and significances of β_{5j} and β_{6j}, respectively. Similarly, the long-run effects of x_{2t}^{+} and x_{2t}^{-} are determined by the signs and significances of normalized coefficients $\frac{-\beta_2}{\beta_1}$ and $-\frac{\beta_3}{\beta_1}$.

3. Empirical Results

Before running the nonlinear ARDL model, we must verify whether the series of the model are stationary. To this end, we apply the unit root test with multiple structural breaks developed by Carrion-i-Silvestre et al. (2009). This test allows up to five structural breaks and may help us to endogenously determine the former main break dates in the Greek economy. For determining the break dates, Carrion-i-Silvestre et al. (2009) developed the following five different test statistics:

$$P_T(\lambda^0) = \{S(\bar{\alpha}, \lambda^0) - \bar{\alpha} S(1, \lambda^0)\} / s^2(\lambda^0) \tag{11}$$

$$MP_T(\lambda^0) = [c^{-2} T^{-2} \textstyle\sum_{t=1}^{T} y_{t-1}^2 + (1 - \bar{c})\, T^{-1} y_T^2] / s(\lambda^0)^2 \tag{12}$$

$$MZ_\alpha(\lambda^0) = (T^{-1} y_T^2 - s(\lambda^0)^2)(2T^{-2} \textstyle\sum_{t=1}^{T} y_{t-1}^2)^{-1} \tag{13}$$

$$MSB(\lambda^0) = (s(\lambda^0)^{-2} T^{-2} \textstyle\sum_{t=1}^{T} y_{t-1}^2)^{-1/2} \tag{14}$$

$$MZ_t(\lambda^0) = (T^{-1}y_T^2 - s(\lambda^0)^2)(4s(\lambda^0)T^{-2}\sum_{t=1}^{T} y_{t-1}^2)^{-1/2} \tag{15}$$

In these test statistics, the null hypotheses of "MZ_α, MZ_t" and "P_T, MSB, MP_T" are “have a unit root” and “be stationary”, respectively. The unit root test with multiple structural breaks was statistically obtained from the Gauss 10 program. The results of this test are reported in Table 1.

Table 1: Results of Unit Root Test with Multiple Structural Breaks

Variable	P_T	MP_T	MZ_α	MSB	MZ_t	Structural Break Dates
M	40.30 (9.24)	34.62 (9.24)	-12.82 (-47.88)	0.18 (0.10)	-2.42 (-4.87)	2003:M11; 2007:M05; 2009:M06; 2012:M06; 2014:M12
$\boldsymbol{p}$	7.28** (9.33)	6.85** (9.33)	-66.98** (-47.68)	0.08** (0.10)	-5.77** (-4.85)	2004:M05; 2007:M08; 2009:M08; 2011:M08; 2015:M02
Y	5.51** (9.47)	5.32** (9.47)	-86.55** (-47.42)	0.07** (0.10)	-6.57** (-4.84)	2004:M07; 2008:M01; 2011:M09; 2013:M06; 2015:M04
$\boldsymbol{\Delta m}$	4.84** (9.39)	4.69** (9.39)	-97.78** (-47.79)	0.07** (0.10)	-6.98** (-4.86)	2004:M07; 2006:M11; 2012:M05; 2015:M05

Note: (**) denotes statistical significances at 5% level. The critical values in parentheses were obtained by bootstrap with 1000 replications.

Test results in Table 1 indicate that the series of m and p, y are $I(1)$ and $I(0)$, respectively. Thus, the bounds testing, developed by Pesaran et al. (2001), is applied for determining the existence of cointegration relations between series. The results of bounds testing, and of the structural break dates are reported in Table 2.

Table 2: Test Results of Bounds Testing and Structural Break Dates

Model	F stat.	Critical Values						Structural Break Dates
		I0 Bound			I1 Bound			
		10%	5%	1%	10%	5%	1%	
$y = f(m^{+}, m^{-})$	3.66*	2.71	3.23	4.35	3.45	4.05	5.39	2008:M07; 2011:M10; 2015:M05
$p = f(m^{+}, m^{-})$	4.90**	2.71	3.23	4.35	3.45	4.05	5.39	2008:M03; 2011:M06; 2014:M11
$m = f(y^{+}, y^{-})$	4.42**	2.71	3.23	4.35	3.45	4.05	5.39	2005:M10; 2009:M08; 2012:M03; 2015:M04
$m = f(p^{+}, p^{-})$	1.90	2.71	3.23	4.35	3.45	4.05	5.39	2009:M09; 2015:M04

Note: (*) and (**) denote statistical significances at 10% and 5% levels. The break dates were obtained by the method of Bai and Perron (2003).

The results in Table 2 reveal cointegration relations only for the first three models, since the *F*- statistics of these models exceed the upper bonds. Hence, no further steps analyses were carried out for $m = f(p^{+}, p^{-})$. Estimates of the nonlinear ARDL model and the model's diagnostic statistics are reported in Table 3.

Table 3: Nonlinear ARDL Model Estimation Results

Variables	$\boldsymbol{p = f(m^+, m^-)}$	Variables	$\boldsymbol{y = f(m^+, m^-)}$	Variables	$\boldsymbol{m = f(y^+, y^-)}$
Short-Run Coefficients					
$\boldsymbol{\Delta p_{t-6}}$	0.38*** (0.00)	Δy_{t-1}	-0.69*** (0.00)	Δm_{t-1}	0.14** (0.02)
$\boldsymbol{\Delta p_{t-7}}$	0.05 (0.11)	Δy_{t-2}	-0.33*** (0.00)	Δm_{t-3}	0.11* (0.09)
$\boldsymbol{\Delta p_{t-12}}$	0.64*** (0.00)	Δy_{t-3}	-0.56*** (0.00)	Δm_{t-4}	0.15** (0.01)
$\boldsymbol{\Delta m^+_{t-5}}$	-0.11** (0.01)	Δy_{t-4}	-0.39*** (0.00)	Δm_{t-6}	0.13** (0.03)
$\boldsymbol{\Delta m^+_{t-9}}$	0.05** (0.01)	Δy_{t-6}	-0.27*** (0.00)	Δm_{t-7}	-0.15** (0.01)
$\boldsymbol{\Delta m^-_{t}}$	-0.15*** (0.00)	Δy_{t-7}	-0.29*** (0.00)	Δm_{t-10}	0.10* (0.06)
$\boldsymbol{\Delta m^-_{t-8}}$	-0.04 (0.12)	Δy_{t-11}	0.34*** (0.00)	Δm_{t-12}	0.26*** (0.00)
$\boldsymbol{\Delta m^-_{t-12}}$	0.10*** (0.00)	Δm^+_{t-5}	-0.94*** (0.00)	Δy^+_{t-1}	-0.09 (0.10)
$\boldsymbol{\Delta m^-_{t-2}}$	-0.10*** (0.00)	Δm^+_{t-8}	-0.56*** (0.00)	Δy^+_{t-8}	-0.18*** (0.00)
$\boldsymbol{\Delta d_{2011}}$	0.006* (0.05)	Δm^-_{t-4}	-0.85*** (0.00)	Δy^+_{t-10}	0.10* (0.06)
$\boldsymbol{\Delta d_{2014}}$	0.01 (0.11)	Δm^-_{t-5}	1.01*** (0.00)	Δy^-_{t-3}	-0.08* (0.09)
-	-	-	-	Δd_{2012}	0.02 (0.12)
$\boldsymbol{ECT_{t-1}}$	-0.07*** (0.00)	ECT_{t-1}	-0.02***(0.00)	ECT_{t-1}	-0.008*** (0.00)
Normalized Long-Run Coefficients					
$\boldsymbol{m^+_t}$	0.53*** (0.00)	m^+_t	0.79 (0.19)	y^+_t	3.57 (0.10)
$\boldsymbol{m^-_t}$	0.37** (0.04)	m^-_t	1.06* (0.05)	y^-_t	3.07 (0.10)
$\boldsymbol{D_{2008_t}}$	-0.06 (0.48)	D_{2008_t}	-0.84 (0.16)	D_{2005_t}	1.10 (0.34)
$\boldsymbol{D_{2011_t}}$	-0.47 (0.63)	D_{2011_t}	1.12 (0.13)	D_{2009_t}	0.81 (0.45)
$\boldsymbol{D_{2014_t}}$	-0.48 (0.36)	D_{2015_t}	1.09 (0.46)	D_{2012_t}	-2.03 (0.27)
-	-	-	-	D_{2015_t}	-1.72 (0.18)
Diagnostic Tests					
$\boldsymbol{R^2}$	0.95	R^2	0.80	R^2	0.45
$\boldsymbol{Adj. R^2}$	0.95	$Adj. R^2$	0.78	$Adj. R^2$	0.39
F	241.04*** (0.00)	F	39.38*** (0.00)	F	7.54*** (0.00)
$\boldsymbol{DW}$	2.08***	DW	1.85*	DW	1.90**
$\boldsymbol{\chi^2_{SC}}$	0.25*** (0.78)	χ^2_{SC}	1.80*** (0.24)	χ^2_{SC}	1.85*** (0.17)
$\boldsymbol{\chi^2_{FF}}$	2.54*** (0.11)	χ^2_{FF}	0.005*** (0.99)	χ^2_{FF}	0.30*** (0.58)
$\boldsymbol{\chi^2_{NOR}}$	47.65*** (0.41)	χ^2_{NOR}	17.60*** (0.15)	χ^2_{NOR}	18.02*** (0.12)
$\boldsymbol{\chi^2_{HET}}$	194.21*** (0.11)	χ^2_{HET}	39.98*** (0.21)	χ^2_{HET}	31.87*** (0.32)
$\boldsymbol{W_{LR}}$	-0.15*** (0.00)	W_{LR}	0.26* (0.08)	W_{LR}	-0.49 (0.13)
$\boldsymbol{W_{SR}}$	0.03 (0.58)	W_{SR}	-1.66*** (0.00)	W_{SR}	-0.08 (0.45)

*Note: ***, ** and * denote statistical significances at 1%, 5% and 10% levels respectively. The values in parentheses indicate prob. values.* W_{LR} *and* W_{SR} *are long and short-run Wald tests. Normalized long-run coefficients are obtained with* $m_t^+ = -\beta_2/\beta_1$, $m_t^- = -\beta_3/\beta_1$. *DW; Durbin-Watson autocorrelation test,* χ^2_{SC} *is Breusch-Godfrey LM test for autocorrelation,* χ^2_{NOR} *is the Jarque-Bera test for normality,* χ^2_{FF} *is Ramsey test for functional form misspecification,* χ^2_{HET} *for Breusch – Pagan - Godfrey heteroscedasticity test. All model specification test results are reliable.*

Normalized estimates of coefficients in Table 3 for the first model $[p = f(m^+, m^-)]$ indicate that both increases and decreases in money stock (m^+, m^-) have partial *positive* sign impacts on price level (p) since the coefficients of $m^+$and m^- are significant in the long-run. A positive sign denotes movements of m^+, m^- and p in the same direction (↑, ↑, ↑). In other words, rises in money stock (m^+) lead to increases in inflation (p) and drops (m^-) lead to decreases. Accordingly, the impacts of both $m^+$and m^- on p will verify the validity of partial QTM. However, the sizes of these impacts reveal that the QTM is weakly valid for Greece, because the coefficient values of both $m^+$and m^- (0.53 and 0.37) are below 1 (*one-to-one*).

Normalized estimates of coefficients for the second model [$y = f(m^+, m^-)$] in Table 3 indicate that while increases in money stock (m^+) have no impacts on income (y), decreases in money stock (m^-) have partial impacts (1.06) in the long-run. This means that only decreases in money stock (m^-) support the QTM partially. From a theoretical perspective, the *classical dichotomy is not valid through* m^-. From the Greek economic policy makers' perspective, it should be noted that decreases in money stock (m^-) lead to more than *one-to-one* proportional decreases on Greek income (y). Therefore, this may be interpreted as a disadvantage for the Bank of Greece (BoG) which cannot increase money stock independently.

Finally, normalized estimates of coefficients in Table 3 for the third model [$m = f(y^+, y^-)$] indicate that both increases and decreases in income (y^+, y^-) do not have any partial impacts on money stock (m), since the coefficients of y^+ and y^- are insignificant in the long-run. This supports the validity of the QTM partially through income increases and decreases (y^+, y^-), since we were not seeking for cointegrated relations from both $y^+$and y^- to m for the validity of the QTM.

Under the joint evaluation of these three alternative models, it can be concluded that the QTM is weakly and partially valid for Greece in the long-run, since (*i*): the partially proportional impact sizes of both increases and decreases in money stock (m^+, m^-) on inflation (p) are less than *one-to-one* (unitary) (this denotes weak validation); (*ii*): income increases and decreases (y^+, y^-) have no partial impacts on money stock (*m); (iii):* decreases in money stock (m^-) have partial impacts on income (y).

Furthermore, the Wald test confirms that money stock increases and decreases (m^+, m^-) have asymmetric impacts on inflation (p) in the long-run and symmetric impacts in the short-run, since the *prob.* values of W_{LR} and W_{SR} are 0.00 and 0.58, respectively. The null hypothesis of the Wald test is "there is symmetry". Hence, the null hypothesis can be rejected in the long-run, but not in the short-run.

4. Concluding Remarks

This study re-visits the Quantity Theory of Money (QTM) for the case of Greece. When it does this, it approaches this theory from potentially nonlinear (asymmetric) relations between the variables in the *equation of exchange.* This methodological approach makes this study different from previous empirical studies, which were constructed on the assumption of linear (symmetric) relations. To this aim, for the first time, the nonlinear ARDL model has been applied for this country (or any other country). This model decomposes the independent variables *money stock* (m), *price level* (p), and *income* (y) in the *equation of exchange* into their increases and decreases, as (m^{+}, m^{-}) , (p^{+}, p^{-}) , (y^{+}, y^{-}). Therefore, it enables us to examine the validity of the QTM through these increases and decreases separately (*partially*). The new methodological approach of this study may be interpreted as a new version of *partial QTM* testing, which is the main contribution of this empirical study to relevant literature.

The empirical findings of this study reveal that the QTM is weakly and partially valid for Greece in the long run. This may emerge not only from the structure of the Greek economy, the behavior of Greek people's financial preferences-priorities and the Bank of Greece (BoG)'s monetary policies, but also from the European central Bank's (ECB) monetary policies and the behavior of the other euro area countries' people's financial preferences-priorities, since Greece is a euro area country. Accordingly, it should be considered that the QTM for Greece in this study is tested by both the *Greek contribution* and other euro area countries' *contributions* to euro area jointly. This study shows the need for country-level QTM empirical analyses for other euro area countries as well. These studies may provide a clearer picture to examine the impacts of each euro area country's and the ECB's money aggregates contributions on the inflation rates in these euro area countries within this complex structure of using a common currency.

Data set: The monthly data of money stock (M2) and CPI were obtained from the website of the Bank of Greece. The Industrial Production Index (IPI) was used as a proxy of real income. The monthly IPI index was obtained from the data set of the

Federal Reserve (FED) Bank of St. Louis. The sample period of the study is 2002M03-2019M06.

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