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Roberto Cellini and Alessandro Paolino

University of Catania

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Roberto Cellini and Alessandro Paolino [*]

(*University of Catania – Faculty of Economics*)

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Abstract

The paper analyses the cointegration relationships and the causal links between the exchange rate of the US Dollar, on the one side, and different price indices of US products on the other side. Data are of monthly frequency and cover a period of two or three decades. We show that the exchange rate cointegrate with the Consumer Price Index and with the prices indices of several agricultural, manufactured and service goods; moreover a one-direction causal link is present, running from price to exchange rate. On the opposite, cointegrating relationships between exchange rate and price indices do not exist in the case of recreational products with "cultural" content. Tentative theoretical explanations are proposed.

J.E.L. Classification: Z10, C22, C32, F13.

Keywords: Price Index; Exchange Rate, Cointegration, Causality.

Corresponding author
Roberto Cellini
(c/o Faculty of Economics - University of Catania)
Corso Italia 55 - 95129 Catania (CT), Italy
E-mail "cellini@unict.it".
Tel. +39 095 375344 (ext. 237); Fax +39 095 7537510

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1. Introduction

The relationship between exchange rate, on the one side, and price level on the other side, is an evergreen in theoretical and applied economics. Different theories predict different links between these variables. A lot of empirical investigation on the relationship between prices and exchange rates is also available, with very mixed results, depending on the considered data and methods.

Roughly speaking, two empirical approaches have been developed. The first one involves the construction and estimation of "large" models, in which several relationships connect these variables with other factors. At least in principle, this allows a detailed explanation of several features of the movements of price and exchange rate. However, the consensus on the relevant links is not unanimous. Several researchers have therefore developed an alternative data-oriented approach that favours simple time-series modelling aimed at determining the most relevant economic influences in an "atheoretical" framework; such an approach can be useful in providing empirical answers to "naive" questions concerning the links between price and exchange rate.

This second route is followed by the present paper. In particular, we take a cointegration analysis approach in order to study the pattern of time series. As it is well known, cointegration analysis allows to distinguish the long-run relationships among variables, disentangling them from the short-run components of movements. Cointegration techniques have been already used also in analysing price and exchange rates intensely, providing –also in this case– mixed results (see Edison, 1987, Rogoff, 1996, and Engle, 2000, among many others).

The novelty of this paper rests in documenting a striking evidence based on US data: a long run cointegrating relationship holds between the (nominal effective) US Dollar exchange rate on the one side, and most prices indices on the other side, including the Consumer Price Index, and all considered (nominal) prices indices referred to agricultural and industrial

goods, as well as to some products belonging to the service sector. In any case, the causal link runs in one direction, from price to exchange rate.

The striking evidence is represented by the fact that such a cointegrating relationship does not exist, on the opposite, for any price index referred to recreational products. The recreational goods and services under investigation can be seen as cultural (or popular-cultural) products. We provide a tentative explanation for the absence of cointegrating relationship between recreational products and the exchange rate; the explanation is based on the public intervention in these markets, often aimed at protecting the "cultural diversity".

The paper is organized as follows. Section 2 presents the data; Section 3 explains the method used and shows the results; Section 4 comments and concludes.

2. Data

2.1 Sources and description.

We analyze US data with a monthly frequency over the period 1980-2006.

As for the exchange rate, we consider the nominal effective exchange rate of US dollar provided by the St. Louis Federal Reserve Bank; the value expresses the amount of US dollar equivalent to one unit of foreign currency, so that a devaluation of US dollar corresponds to an increase of the considered index.[1]

As for price indices we rely on the data provided by the Bureau of Labor Statistics (Consumer Price Index by Item and Place).[2]

This paper presents the results concerning 12 different prices indices referred to specific goods' categories, along with the Consumer Price Index (CPI). However, the same exercise has been carried out over further goods' categories (whose data are available from the mentioned sources), with analogous results (results are available upon request). The prices indices considered in the present paper are reported in Table 1. Four goods' categories represent tradable goods (apparel; alcoholic beverage; fuels; energy); four products' categories represent services (medical care; professional services; transportation; private

[1] More precisely, the Trade Weighted Exchange Rate Index - Broad is considered (with January 1997 taking value 100).

[2] All data are free downloadable through the website www.economagic.com.

transportation); four categories represent "cultural" products (recreation; television; educational books; school tuition).

Insert about here : **Table 1 - List of variables**

We chose to analyse seasonally adjusted data –that are provided by the sources, along with the original data. We are aware that our choice of working with season-adjusted data could be questionable, but our primary interest is to focus on long-run links, and the adjusted data allow to avoid the problem of modelling the seasonal components, and permit to have a larger degree of freedom for the long-run analysis we are interested in.

2.2 Integration Analysis

Widespread agreement exists about the I(1) nature of price and exchange rate. Minor doubts have been cast only on consumer price index, sometimes suspected to be I(2), other times suspected to be stationary.[3]

As far as the data at hand is concerned, ADF tests on the series and their first difference lead to the conclusion that all the series are I(1), provided that a linear trend is present and in the absence of structural breaks – see Table 2. (The only variable for which some doubt can emerge is the series of the price of educational books, but the following analysis provides results consistent with its I(1) nature.)

Insert about here : **Table 2 - Dickey Fuller tests for unit root.**

[3] The point of the supporters of the I(2) hypothesis is based on the evidence that the inflation rate is integrated of order 1. However, a large body of empirical evidence suggests that inflation is stationary in the presence of structural breaks. This evidence is documented, for instance, by several working paper of the European Central Bank published in 2004 and 2005 – see, e.g., Dossche and Everaet (2005) or Lunnemann and Matha (2004). On the opposite, the point of the supporters of the I(0) hypothesis is based on the fact that price series can appear to be stationary in the presence of appropriate deterministic structural breaks. The stationarity around a broken deterministic trend is supported, *inter alia*, by Kwiatowski et.al. (1992) and Lippi and Reichlin (1994).

By the way, it is interesting to report that even the real prices of the considered items appear to be non-stationary, according to the ADF tests; it means that the (log) nominal prices of items do not cointegrate with the (log of) CPI or they cointegrate under a vector different from (-1,1).[4] Under this respect, recreational goods have no specificity as compared to other goods –at least within the set of goods we are dealing with: the real price of any considered good is non stationary.

The question we ask is whether some cointegrating relationship between prices and exchange rate holds.

3. Cointegration and causality analysis

Cointegration means that there exists a stationary linear combination between two (or more) non-stationary series; the linear combination can be interpreted as the long-run link between the non-stationary series. In the case of two non-stationary time series X and Y, there is at most one stationary linear combination series. (Extensions allow for more than two series and possibly more than one cointegrating relationship; in this paper however we confine to the case of one cointegration relationship between two series.)

Consider the static equation

[1] $$Y_t = a + bX_t + u_t \quad , \qquad t=1,2,...T \, .$$

If the error term u_t is a stationary process, then X and Y are cointegrated (Engle and Granger, 1987). The appropriate test to evaluate the stationary nature of residuals is the (Augmented) Dickey Fuller test.[5] The regression residuals can be interpreted as the "error" of current variable Y with respect to its long-run equilibrium value dictated by the cointegrating relationship. According to the representation theorem by Granger, if two integrated variables cointegrate, an error correction mechanism is operative, which means that Y and/or X have to move in order to correct the disequilibrium with respect to the long-run relationship.

[4] The cointegration under a vector different from (-1,1) occurs for three items, namely, medical services, transportations, and private transportation; the no-cointegration in the remaining nine cases.

[5] An alternative method to evaluate the cointegration among variables is the one proposed by Johansen, relying on LR Test Based on Maximal Eigenvalue of the Stochastic Matrix.

The cointegration analysis offers powerful tools to look at the causality issue. The representation theorem (Engle and Granger, 1987) states, loosely speaking, that a cointegration relationship can be represented as a model with error correction mechanisms which entails (at least) one Granger causal ordering.

Phillips and Loretan (1992)[6] suggest to look at the significance of the error-correction term directly in order to assess the existence of long run (cointegrating) relationships. This procedure allows to assess the direction of the causality, in the cointegrating relationship.

Specifically, let us consider the following system representing the dynamics of the cointegrated variables *X* and *Y*, where Δ is the first-difference operator and EC denotes the error correction term, i.e., the fitted residuals of the static long-run regression corresponding to eq. [1]:

[2a] $$\Delta Y_t = \beta + \alpha EC_{t-1} + \sum_{i=1} \alpha_i \Delta Y_{t-1} + \sum_{j=1} \lambda_j \Delta X_{t-j} + \varepsilon_t$$

[2b] $$\Delta X_t = \phi + \gamma EC_{t-1} + \sum_{i=1} \gamma_i \Delta X_{t-1} + \sum_{j=1} \eta_j \Delta Y_{t-j} + \varepsilon'_t$$

There are different concepts of causality, with respect to system [2a,b], as concerns either the level or the first difference of variables.

On the one hand, short-run Granger-causality refers to the (stationary) variables ΔY and ΔX. In particular, ΔX is said to be weakly exogenous for the parameters of the regression [2b] if γ is not significantly different from zero. If also coefficients η_j are not significantly different from zero, then there is no Granger-causal link from ΔY to ΔX. In such a case, ΔX is *strongly* exogenous and [2a] can be used for prediction purposes. Obviously the same holds, *mutatis mutandis*, for ΔY, which is weakly exogenous if $\alpha = 0$, and strongly exogenous in the case where also coefficients λ_j are not statistically different from zero.

On the other hand, long-run Granger-causality may also be studied: it refers to the links between the *levels* of *Y* and *X*. Under this perspective, Granger and Lin (1995) propose a measure of the strength of causality between (cointegrated) variables; in particular, the strength of causality of *Y* upon *X* can be approximated by:

[6] See also Kremers et al. (1992) and Inder (1993).

[2c] $$M_{Y\to X} = \log\left[1 + \frac{\gamma^2(1-\rho^2)}{(\gamma\rho-\alpha)^2}\right] \quad , \rho = corr(\varepsilon, \varepsilon')$$

A particular case of such a measure index is the case in which either α or γ are not statistically significant.

Clearly, if α is not different from zero, then $M_{X\to Y} = 0$, i.e., *X* does not cause *Y*. If γ is not different from zero, $M_{Y\to X} = 0$, which means that *Y* does not cause *X*. If simultaneously $\gamma = \alpha = 0$ no error correction mechanism is operative and variables do not cointegrate.

With reference of data at hand, all the mentioned procedures (Engle-Granger, Johansen, Phillips-Loretan) give substantially identical results as concerns the cointegration relationship among variables. For the sake of brevity we report only the procedure *à la* Phillips - Loretan (1992)

For the estimation purpose, we chose to regress the following equations, where *Y* indicates the exchange rate and *X* indicates a price index, in the cases examined in this present paper:

[3a] $$\Delta Y_t = \beta + \alpha Y_{t-1} + \alpha_0 X_{t-1} + \sum_{i=1}\alpha_i \Delta Y_{t-1} + \sum_{j=1}\lambda_j \Delta X_{t-j} + \varepsilon^Y{}_t$$

[3b] $$\Delta X_t = \phi + \gamma X_{t-1} + \gamma_0 Y_{t-1} + \sum_{i=1}\gamma_i \Delta X_{t-1} + \sum_{j=1}\eta_j \Delta Y_{t-j} + \varepsilon^X{}_t$$

Table 4 reports the coefficients' estimates for each pair of variables, corresponding to our preferred specification, in accordance with the significance of the terms of the lag-polinomials of ΔX and ΔY. In particular, we considered the presence of 1st, 2nd, and 12th lag. However, the second and the 12th lag terms appeared to be never significant.

Of course, *Y* and *X* cointegrate if the error correction mechanism is operative. In order to have a stable adjustment process of the variables towards their long-run levels, α and/or γ must lie in the interval (-1, 0). To this end, three possibilities exist: (a) α is included in the interval (-1,0) and it is statistical significant (in this case, *Y* moves in order to adjust the error; if γ is not statistically significant, a one-direction causal link in the long run rums from *X* to

Y); (b) γ is included in the interval (-1,0) and it is statistical significant (in this case, *X* moves in order to adjust the error; if α is not statistically significant, a one-direction causal link in the long run rums from *Y* to *X*); (c) both α and γ are significant and negative parameters included in the interval (-1,0): this means that both variables react to error. If neither α nor γ are included in the interval (-1,0), *X* and *Y* do not cointegrate since the error (that is, the deviation from the long run equilibrium relationship) is not corrected. Eventually, if no error correction mechanism is operative, integrated variables do not cointegrate.

In our analysis we consider the significance at the 15% level (if not differently specified). From Table 3 it is immediate to see what follows.

(i) Parameter α is negative and significant, in nine cases: in the case of the general CPI, and in the eight cases of non-cultural products (both the four tradable items, dress, alcoholic beverages, fuel and energy, and the four services, medical services, professional services, transportations and private transportations); in eight out of these nine cases, parameter γ is zero, denoting that the causal link runs from price to exchange rate (the exception is the private transport service, where the causal link is two-way). Only one out of these nine cases provides an estimate of η not different from zero (alcoholic beverages) meaning strong exogeneity; in the remaining cases, η is statistically different from zero, meaning short-run links and leading to reject the strong exogeneity.

(ii) Parameter α is not statistically different from zero and simultaneously also parameter γ is not statistically different from zero, in each of the four cases pertaining to cultural items, educational books, recreation, cable TV, school tuition fees). This means that no error correction mechanism is operative (in other words, no cointegration links do exist) for such products. Each of these goods is of "cultural nature".

Insert about here: **Table 3 - Long-run causality and short-run dynamics.**

A qualitatively similar evidence is provided by the Granger-Lin index of long-run causality (see Table 4): in the cases of non cultural goods and services the strength of causality running form price to exchange rate is much higher that the strength of the opposite link; in the case of cultural products, the strength of causality is low in both directions.

It is also interesting to note that the long-run elasticity of (nominal effective) exchange rate to consumer price index is equal to $-\alpha_0 / \alpha = 0.878$ and a Wald test on the hypothesis

$\alpha_0 = -\alpha$ can not reject this null ($\chi^2 = 0.1605$, p=0.689). This evidence is of course consistent with the PPP theory, provided that the foreign inflation is zero. A similar conclusion holds fore three out the eight non-cultural products under consideration.

Insert about here: **Table 4. The Granger-Lin *M* statistics**

4. Discussion, policy implications and conclusions

The links between price and exchange rate can be of different nature. On the one hand –just to mention possible links– exchange rate may affect production cost, as long as imported inputs are used. On the other hand, exchange rate has to move in order to make the law of "one price" (and the purchase power parity law) fulfilled.

A lot of empirical work is available about these themes. Four streams of recent (and relevant to our purpose) empirical literature can be listed.

a) The investigation about the property of the real exchange rate, as defined by $RER = E \cdot P^f / P^d$, where E denotes the (bilateral or effective, according to the different analyses) nominal exchange rate, P^f the foreign price level and P^d the domestic price. While E, P^f and P^d are generally accepted to be I(1), different conclusions emerge as concerns *RER*: according to a part of the available literature, *RER* are not stationary (see Rogoff, 1996, just to mention a paper with a comprehensive review); the evidence, however is challenged by different results (Abuaf and Jorion, 1990, Frankel, 1986, 1990, Glen, 1992, and so on); Mussa (1986) provides a discussion about the pros and cons of different procedures and choices about (time and country) sample. In any case, a non stationary nature of RER can not be consistent with the idea that exchange rate move in order to assure the purchasing power parity. Indeed, PPP would imply a constant value for RER. Tests on the PPP theory basing on cointegration property among time series are presented, among other, by Edison (1987), Engel (2000) and Breitung and Candelon (2005).

b) The investigation about the quantitative importance of different reasons for the (possible) failure of the PPP: let us think of the presence of non-tradable goods, the behaviour of the relative price of tradable vs. non-tradable goods, volatile exchange rate, sticky price of goods, and so on. In this vein of literature we have to mention the recent investigation of Betts - Kehoe (2006) and Burstein et al. (2006) who explain the failure of PPP on the basis of

movements of relative price of non-tradable vs. tradable goods in single countries, and the analyses of Giovannini (1988), Engel (1999) and Chari et al. (2002) who find –on the opposite– that differences of price of traded goods can provide a quite exhaustive explanation of the failure.

c) The investigation about the (possible) failure of the law of one price in reference with a specific good; within this stream one can mention Asplund and Friberg (2001), Knetter (1989, 1993), Isard (1977), among many others. All these studies document relevant failures of the one price law, even in the case of homogenous tradable goods.

d) The investigation about the effect of the adhesion to a monetary union upon price dispersion; notably, the experience of the European Monetary Union provides an enormous experimental basis: Baye et al. (2002), Engle and Rogers (2004), Lutz (2002), Rogers (2002) provide evidence about the fact that a certain degree of *reduction* in the prices' dispersion (for specific goods) has been occurring across the EMU countries over the first half of the Nineties, but this process has stopped thereafter, so that the adoption a common money does not appear to enhance the law of one price across countries.

We mentioned such streams of applied economic literature, since our present analysis has something to do with these investigations, even if we have taken a much more restricted perspective. In fact, we have aimed at analyzing the direction of the causal links between exchange rate (on the one side) and price (on the other side), in a basket of goods.

Our main interest has been to assess whether recreational services (i.e., a subset of goods and services belonging to culture, in a broad sense, or "popular culture" in a more restricted sense) show any specificity. Our answer has been positive: while traded goods appear to be linked to exchange rate through a cointegration relationship, and while such a cointegrating links also holds for the considered services, such a link does not emerge in reference to each of the considered recreational (or cultural) products.

We have found a sort of "law"- which holds for all the considered non-cultural products: price and exchange rate are linked by cointegrationg relationship, and the causality runs from price to exchange rate. This law does not hold for the considered cultural products, whose price indices emerge to be not cointegrated with the exchange rate.

The specificity of the long-run pattern of the price of cultural goods and service with respect to different goods deserve some explanations.

It is true that the international markets of cultural goods and services are probably less integrated in comparison to the international markets of agricultural and manufactured goods. In effect, even if the trade of cultural goods and services doesn't find a different treatment in international trade agreements (GATT and GATS), important restrictions are documented by several studies (see, among many others, Guevremont 2006). However, this point has little to do with the non-traded nature of these products: we have found that the cointegrating links hold also for (little tradable) services, like medical care services, or professional services.

It is also true that the public intervention in the considered cultural market is probably heavy. However, the explanation of the exception can not rest only on this fact, provided that public intervention is equally heavy in other sectors considered here, like transportations or medical services.

The cultural goods and services are specific because they have an idiosyncratic content, along with the economic and commercial value. They convey identities, value and meanings and play a special role in a community. Thus, according to some views, culture can not be left to the uncertain tastes of the invisible hand, and the government has to play a role: free trade could be a threat to cultural diversity and national identity; hence, policy has to protect and promote cultural diversity. But, under this respect, cultural policies could represent a form of protectionism.

Cultural protectionism finds its legitimacy also in the concepts of *cultural exception* and *cultural diversity*. On 20th October 2005, the UNESCO General Conference approved the *Convention on the Protectionism and Promotion of the Diversity of Cultural Expressions* that reinforces the notions enshrined in the *UNESCO Universal Declaration on Cultural Diversity* (2001) that cultural diversity is a "common heritage of humanity" and that its defence must be considered "an ethical imperative, inseparable from respect of human dignity".

Every country in the world treats at least some aspect of its domestic cultural life as a public goods, even if the range of activities receiving government support varies widely across countries and regions. Several countries, like Canada and France, subsidize own production and exportation of cultural goods and services clearly adopting a form of cultural protectionism. In some European countries, including Italy, fix price arrangements on cultural

[7] The literature on cultural diversity and multiculturalism is becoming very wide; see Petkova (2006) or Uslaner (2006) just to mention interesting recent contributions; see also Hahn (2006) with a focus on the legal aspects, and Foà and Santagata (2004) with focus on the economics aspects.

goods (notably, books) are permitted (or were permitted during part of time-sample we have analysed), contrary to the US, and so on.

Under this respect, active cultural policy –enhancing goods' differentiation– represents an obstacle to arbitrage force in markets, thus contributing to the failure of the one-price law in the markets of goods with cultural content, and eventually to the PPP principle. This holds irrespective of the tradable nature of products involved.

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TABLES

Table 1 - List of variables

LNEER = log of nominal effective exchange rate
LCPI= log of consumer price index

LPDRESS= log of price of apparel
LPALCB = log of price of alcoholic beverages
LPFUEL = log of price of fuels
LPENERG= log of price of energy

LPMEDS= log of price of medical care services
LPPROS= log of price of professional services
LPTRA= log of price of transportation
LPPRTRA= log of price of private transportation

LPEDBOOK= log of price of educational books and supplies
LPRECR = log of price of recreation
LPCTV = log of price of cable television
LPELHIS = log of price of elementary and high school tuition and fees

Table 2 - Dickey Fuller tests for unit root.

	DF	ADF_1			DF	ADF_1
LNEER	-1.077	-1.586		Δ LNEER	-11.908	-10.326
LCPI	-3.004	-2.382		Δ LCPI	-11.132	-10.556
LPDRESS	-0.425	-0.412		Δ LPDRESS	-16.413	-12.085
LPALCB	-0.941	-1.151		Δ LPALCB	-13.963	-11.860
LPFUEL	-0.628	-1.310		Δ LPFUEL	-13.514	-10.234
LPENERG	-1.118	-2.106		Δ LPENERG	-12.167	-13.585
LPMEDS	-4.51	-2.58		Δ LPMEDS	-6.940	-4.450
LPPROS	-3.52	-3.24		Δ LPPROS	-10.154	-6.496
LPPRTRA	-3.010	-3.475		Δ LPPTRA	-12.086	-14.204
LPTRA	-3.010	-3.52		Δ LPTRA	-12.039	-13.986
LPEDBOOK	-3.736	-3.806		Δ LPEDBOOK	-17.379	-15.651
LPRECR	-1.686	-1.561		Δ LPRECR	-14.668	-8.819
LPCTV	-1.360	-1.852		Δ LPCTV	-10.223	-8.877
LPELHIS	-2.543	-2.850		ΔLPELHIS	-24.874	-16.226

NOTES: Δ denotes the first-difference operator. ADF tests are reported. For variables in level, the trended case is considered (the 5% critical value is: -3.426) For variable in first-difference the nontrended case is considered (the 5% critical value is: -2.871)

Table 3 - Long-run causality and short-run dynamics.

Y = LNEER X = LP*	α (ECM coef)	β	α_0	α_1	λ_1	Regression Statistics	γ (ECM coef)	ϕ	γ_0	γ_1	η	Regression statistics
LCPI	−0.0131 (−1.702) [0.090]	0.0031 (0.137) [0.891]	0.0115 (1.065) [0.288]	0.3480 (6.584) [0.000]	−0.0138 (−0.049) [0.961]	R2=0.16 DW=1.94 h=1.63	0.0016 (0.811) [0.418]	0.0067 (1.602) [0.110]	−0.0030 (−2.091) [0.037]	0.4097 (7.900) [0.000]	0.0074 (0.756) [0.450]	R2=0.34 DW=1.91 h=2.13
LPDRESS	−0.0118 (−3.471) [0.001]	−0.0425 (−1.158) [0.248]	0.0203 (2.032) [0.043]	0.3366 (6.440) [0.000]	−0.2302 (−1.538) [0.125]	R2=0.17 DW=1.94 h=1.52	0.0026 (0.684) [0.495]	0.0121 (0.874) [0.383]	−0.0054 (−4.162) [0.000]	−0.0371 (−0.655) [0.513]	0.0107 (0.540) [0.590]	R2=0.12 DW=2.00 h=ND
LPALCB	−0.0125 (−1.792) [0.074]	0.0047 (0.216) [0.829]	0.0106 (1.069) [0.286]	0.3472 (6.553) [0.000]	−0.0184 (−0.104) [0.917]	R2=0.16 DW=1.94 h=1.69	0.0005 (0.148) [0.883]	0.0089 (1.323) [0.187]	−0.0021 (−0.956) [0.340]	0.2190 (3.970) [0.000]	0.0291 (1.760) [0.079]	R2=0.10 DW=1.95 h=2.98
LPFUEL	−0.0053 (−1.503) [0.134]	0.0237 (1.054) [0.293]	0.00036 (0.050) [0.960]	0.3431 (6.515) [0.000]	0.0566 (0.883) [0.378]	R2=0.16 DW=1.94 h=1.55	−0.0017 (−0.272) [0.786]	0.0165 (0.853) [0.394]	−0.0015 (−0.488) [0.626]	0.2841 (5.1424) [0.000]	−0.0322 (−0.710) [0.478]	R2=0.09 DW=2.01 h=−.75
PLENERG	−0.0054 (−2.120) [0.035]	0.2521 (1.496) [0.136]	0.00015 (0.033) [0.974]	0.3412 (6.468) [0.000]	0.0004 (0.011) [0.991]	R2=0.15 DW=1.94 h=1.72	−0.0096 (−1.214) [0.226]	0.0273 (0.956) [0.340]	0.0044 (1.013) [0.312]	0.3520 (6.426) [0.000]	0.0132 (0.148) [0.882]	R2=0.12 DW=1.80 h=9.13
LPMEDS	-0.012 (-1.598) [0.111]	0.030 (2.251) [0.025]	0.005 (0.899) [0.369]	0.347 (6.555) [0.000]	-0.147 (--0.360) [0.719]	R2=0.157 DW=1.94 h=1.61	0.0001 (0.818) [0.414]	0.013 (7.932) [0.000]	-0.003 (-3.812) [0.002]	0.464 (9.378) [0.000]	0.001 (0.138) [0.890]	R2=0.59 DW=2.24 h=-4.55
LPPROS	-0.012 (-1.577) [0.116]	0.022 (1.534) [0.126]	0.007 (0.953) [0.341]	0.348 (6.566) [0.000]	-0.011 (-0.024) [0.980]	R2=0.157 DW=1.94 h=1.67	-00004 (-0.430) [0.667]	0.022 (12.68) [0.000]	-0.004 (-3.867) [0.000]	0.052 (0.936) [0.350]	-0.002 (-0.275) [0.783]	R2=0.528 DW=2.03 h=-1.75
LPTRA	-0.013 (-2.134) [0.034]	-0.011 (-0.400) [0.689]	0.015 (1.355) [0.176]	0.346 (6.589) [0.000]	0.010 (0.140) [0.888]	R2=0.160 DW=1.94 h=1.58	-0.010 (-1.359) [0.175]	0.035 (1.749) [0.081]	0.004 (0.891) [0.373]	0.369 (6.785) [0.000]	0.016 (0.436) [0.663]	R2=0.140 DW=1.77 h=9.11
LPRRTRA	-0.012 (-2.09) [0.037]	-0.10 (-0.343) [0.732]	0.014 (1.259) [0.209]	0.345 (6.756) [0.000]	0.007 (0.106) [0.915]	R2=0.159 DW=1.94 h=1.59	-0.012 (-1.475) [0.141]	0.039 (1.777) [0.076]	0.005 (1.047) [0.298]	0.373 (6.911) [0.000]	0.014 (0.339) [0.734]	R2=0.140 DW=1.77 h=7.90
LPDBOOK	−0.0064 (−0.912) [0.363]	0.0251 (2.791) [0.006]	0.00094 (0.176) [0.860]	0.3438 (6.419) [0.000]	0.0372 (0.355) [0.723]	R2=0.16 DW=1.93 h=2.03	−0.0031 (−1.066) [0.287]	0.0223 (4.628) [0.000]	−0.00017 (−0.045) [0.964]	−0.0372 (−0.661) [0.509]	0.0153 (0.532) [0.595]	R2=0.05 DW=2.02 h=ND
LPRECR	−0.0095 (−0.823) [0.411]	0.1066 (1.396) [0.165]	−0.0132 (−0.542) [0.589]	0.3076 (4.039) [0.000]	0.2191 (0.523) [0.602]	R2=0.15 DW=1.90 h=3.03	−0.0041 (−0.909) [0.365]	0.0297 (2.114) [0.036]	−0.0020 (−0.932) [0.353]	−0.1999 (−2.598) [0.010]	0.01972 (1.409) [0.161]	R2=0.10 DW=2.00 h=.003
LPCTV	−0.0069 (−0.774) [0.440]	0.0681 (2.613) [0.010]	−0.0062 (−0.915) [0.361]	0.3300 (4.570) [0.000]	−0.1605 (−1.050) [0.295]	R2=0.18 DW=1.89 h=2.56	−0.0025 (−0.757) [0.450]	−0.0034 (−0.267) [0.790]	0.0043 (0.991) [0.323]	0.1677 (2.238) [0.026]	0.0474 (1.338) [0.183]	R2=0.05 DW=1.94 h=3.52
LPELHIS	−0.0079 (−1.134) [0.258]	0.0261 (2.487) [0.013]	0.0019 (0.429) [0.668]	0.346 (6.507) [0.000]	0.0874 (0.800) [0.424]	R2=0.16 DW=1.94 h=1.87	−0.0012 (−0.577) [0.564]	0.0301 (6.040) [0.000]	−0.0034 (−1.025) [0.306]	−0.3943 (−7.612) [0.000]	−0.0160 (−0.634) [0.527]	R2=0.19 DW=2.17 h=−4.08

NOTES. The Table reports the estimates of parameters of eqs. [3a] and [3b].t-stat. in parenthesis, p-vaule in squared brackets.

Table 4 - The Granger-Lin *M* statistics

	$M_{x\to y} \equiv M_{p\to e}$	$M_{y\to x} \equiv M_{e\to p}$
LCPI	8.891	0.014
LPDRESS, LPALCB, LPFUEL, LPENERG (average)	2.438	0.346
LPMEDS, LPPROS, LPTRA, LPPRTRA (average)	3.021	0.386
LPDBOOK, LPRECR, LPCTV, LPELHIS (average)	1.588	0.384