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The Influence of Interest on Prices. A Non-Orthodox Wicksellian Interpretation[1]

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ABSTRACT

Widespread criticism has been levelled at the conventional interpretation of the natural rate of interest. In the present paper, we aim to test the validity of a non-orthodox approach to Wicksell's contribution, as developed by Edward Nell, 1998, 1999. Its most remarkable aspects are the following: (i) the natural rate is ruled by the rate of growth of output; (ii) when a gap between this natural and the monetary rate of interest arises, there is a change in the rate of growth of stock prices, not necessarily in commodity prices, and (iii) the monetary interest rate follows the natural one without reaching it. We have used three stage least squares on data taken from the US economy covering a period from 1955 to 2005. The main conclusions are: (i) the rate of growth of output affects the rate of change of stock prices positively, (ii) although the central bank has great control over the long term real interest rate, through changes in the short term interest rate, changes in stock prices affect it positively, (iii) there is Granger causality running from the percentage change of (deflated) stock prices to the long term real interest rate.

JEL CLASSIFICATION: G1

KEYWORDS: Natural rate of interest, Wicksell, stock prices, US economy, multi-equation system

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1. INTRODUCTION

Nowadays, the implementation of monetary policy occurs through changes in the short term interest rate, as described by the Taylor's rule. And to do so, amongst other things an equilibrium rate of interest has to be computed. This equilibrium rate is usually identified with the Wicksellian natural rate of interest (cf. Wicksell, 1898).

With regards to this rate, it is usually assumed that:

- it is ruled by the marginal productivity of capital;
- it is the rate which matches savings and investment decisions at the potential output level;
- if the monetary interest rate equals the natural rate, inflation remains stable.

However, these assumptions have attracted strong criticism. For instance:

- the Sraffian-based capital critique has demolished the concept of marginal productivity of capital;
- the endogenous theory of money has shown that savings and investment are not independent functions and that the interest rate does not and cannot match them;
- by and large, inflation is more often a cost push than a demand pull phenomenon.

Despite these criticisms, we may wonder whether Wicksell's contribution is of any use nowadays. In our view, following Nell's lead (Nell, 1998, 1999), we believe that an alternative interpretation of Wicksell is still relevant for an understanding of the working of a modern capitalist economy.

The aim of this paper is to investigate whether this alternative interpretation fits the experience of the US economy for the period 1954:Q4 to 2005:Q4. Our conclusions support this view.

2. AN ALTERNATIVE INTEPRETATION OF THE INFLUENCE OF THE INTEREST RATE ON PRICES.

Following Nell, 1998, 1999, we can distinguish, like Wicksell (cf. Wicksell, 1898, 1907), two interest rates. First, we have *the* money interest rate which is the interest rate at which banks make loans and credits. Second, there is *the* natural rate of interest which stands for the rate of profit on capital.

At this point our path begins to diverge from Wicksell. In our view, the natural rate of interest cannot be determined by the marginal productivity of capital. The Sraffian-based capital critique demolishes the marginalist theory of distribution. As an alternative, we follow the NeoKeynesian strand (e.g. Kaldor, 1956; Pasinetti, 1974). Here the profit rate is regulated by the rate of growth of the stock of capital (and the propensity to save of capitalists).

Our second discrepancy with Wicksell is strongly connected to the former. Following Keynes, we assume that the principle of effective demand holds so that output is ruled by demand, which is considered exogenous. Output does not necessarily gravitate around a full employment position.

Like Wicksell, we assume that money is endogenous. The interest rate at which banks make loans is to a great extent controlled by the central bank (the latter controls the very short term nominal interest rate and we are interested in longer term real interest rates).

Contrary to Wicksell, however, when the natural rate of interest, r, differs from the money rate of interest, i, we assume that commodity prices need not change. Our third difference of opinion consists in assuming that when there is any discrepancy between both rates, there will be changes in stock prices, and not necessarily in commodity prices. The argument runs as follows.

Assuming a Harrodian neutral technical change, output and productive capacity grow at similar rates, g. Also, income shares remain stable. Hence, we find that the rate of profit is ruled by g, the rate of growth of output. When this is so, and if the number of shares representing the ownership of capital remains constant, their corresponding prices should rise at a rate $s = g$, reflecting the growth of profits.

On the other hand, we can assume temporarily that the money interest rate, i, equals the natural rate, r.

Let us assume this equilibrium situation:[2]

(1) $i = r = g = s$

[2] This equilibrium situation can be interpreted in two ways. Firstly as a Golden Rule; secondly not in levels but in first differences. Thus, expression (1) should be written as:

(1.*bis*) $i_t - i_{t-1} = r_t - r_{t-1} = g_t - g_{t-1} = s_t - s_{t-1}$

In the second case, of course the level of the variables need not coincide. Then, arbitrage (as shall be shown below) occurs when there is a change in the rate of growth of output whilst the "conventionally" accepted level of the rate of interest remains stable.

This interpretation can be extended to the rest of our expressions.

In this paper we follow the second interpretation.

Next, we may wonder what happens when, for instance, g increases. If the money rate of interest does not follow this shift, we have:

(2) $i < r + \Delta r = g + \Delta g = s + \Delta s$

When g rises, r and s follow suit.

For the sake of simplicity we shall assume that commodity prices remain stable, as stated above.

The next step is as follows. When asset holders realize that they can make an extra profit if they purchase shares now and sale them in the future, they will shift their portfolios from bonds towards equities. This shift will lead to an excess supply in the bond market depressing bond prices and making their yield rise and to an excess demand in the stock market, making stock prices rise still further.

Thus, when stock prices rise, the money interest rate rises as well:

(3) $\Delta i < \Delta\Delta s$

There may be a cumulative process within the rise of stock prices, but they are not going to rise indefinitely.[3] The money interest rate i parallels s but the former does not reach the latter. And "second round" increases of s (because of arbitrage) do not reflect increasing profits: this increase is due to speculation. When shareholders do not gain the returns they expected on the stock market, equity sales will accelerate, mania will turn to panic and lead to a stock market crash, to paraphrase Kindleberger, 1989.

Let us now return to the money interest rate. In our view it can be broken down into two components. First, long term interest rates are understood as a weighted average of expected future short term interest rates, plus a premium which depends on liquidity, risk and other factors regarding the desirability of the financial instrument under consideration. Second, these long term interest rates are affected by returns on alternative assets.[4] In our view, when the central bank has a high level of credibility and implements a persistent monetary policy (high or low levels for the interest rate) it can make agents accept a certain value of the interest rate as *the* reference value which shall be used, i.e. the present value of future corporate profits. This is encapsulated in the first component of long term interest rates. And their level may differ from the rate of

[3] This cumulative process may be exacerbated when there is a speculative demand for credit.

[4] Arbitrage will lead to an increasing yield of bonds even with stable short term interest rates. Banks will also put up the interest on long term credits in order to increase bank profits and, thus, bank capital. Wicksell, 1907, believed that banks would increase the interest at which they lent because reserves would fall in relationship to bank liabilities.

growth.[5] What is relevant for the cumulative process in stock prices is not the comparison of the level of the interest rate and the rate of growth of output but changes in the former and the latter. This discrepancy is expected to lead to a speculative process which may give rise to changes in the second component of the long term interest rate.

In the absence of commodity inflation we shall assume that short term interest rates remain stable. Hence, if *g* shifts upwards, beyond a certain threshold level (we could be entering a period of economic prosperity) so that the gap between *g* and the short term interest rate widens, both *s* and *i* will move upwards paralleling each other.

Alternatively, when there is inflation and *g* reaches this threshold, then we should expect the short term interest rate, the monetary rate and the price of shares to increase. In this case, when inflation is on the rise, two things should be taken into account: (i) There may be a spurious correlation between the money rate, *i* and *s* when the former is determined by the short term interest rate and the latter is highly correlated with *g*. To avoid this problem, we should focus on the interest gap, i.e. we should expect the gap between *i* and the short term interest rate to widen when *s* rises. (ii) Perhaps, when prices rise, the monetary authority will put the short term interest rate up, making the longer term interest rates go in the same direction and making *s* fall, as the current value of future profits falls. If this outcome becomes predominant, the model becomes irrelevant.

There is at least one further question regarding the financing of output growth. Here we should assume that the main source is retained earnings and / or bank credit, with bond and stock markets taking a back seat. When this is so, the amount of bonds and shares remains stable and demand shifts lead to price changes.

3. SOME ECONOMETRIC EVIDENCE

The main hypothesis to be tested is the following. We shall assume that when *g* rises, and this is not matched by an increase in the short term interest rate, i^R_{ST}, the price of shares *s* increases and then, the interest gap, defined as i^R_{LT} minus i^R_{ST}, rises as well. In the most favourable case, inflation should be irrelevant, though this is not essential for the validity of our hypothesis. However, if the rise in i^R_{ST} is significant enough, it may cancel out the impact of *g* on *s*.

[5] In fact, the long term real interest rate has been systematically greater than the real ouput growth rate for the last 25 years of the last century.

The data

We have used the following series with a quarterly frequency, covering the period 1954:4 to 2005:4.

- Inflation. We use the producer price index, downloaded from the Bureau of Labour Statistics (Series ID: PPIACO). The frequency of the data is monthly. Then we obtain the average quarterly level and next its percentage change. This variable shall be called *p*.
- Standard & Poor 500. We take monthly data from http://uk.finance.yahoo.com. Next, we divide monthly datum by the producer price index for each corresponding month. Then, we calculate the average value for each three months and obtain the quarterly percentage change.[6] This we shall call *s*.
- Long term interest rate. We take the 10 years US Treasury constant maturity rate from the Federal Reserve System (H.15 Selected interest rates) with a monthly frequency. As above, we discount inflation and then calculate the average rate for each quarter. Next we obtain the quarterly interest rate. We shall call this variable in real terms $i^R{}_{LP}$. In our model it is identified with the money interest rate, *i*.
- Short term interest rate. We take the effective federal funds rate from the Board of Governors of the Federal Reserve (H.15 Selected interest rates) with a monthly frequency. Again, we discount inflation and then obtain the average annual rate for each quarter. Next we calculate the quarterly interest rate. This we shall call $i^R{}_{ST}$.
- Rate of growth of output. We use the series of real GDP, 1 decimal (ID Series: GDPC1) from the US Department of Commerce (Bureau of Economic Analysis), in billions of chained 2000 dollars, with a quarterly frequency. We shall call this variable *g*.

(Links to this data can be found at www.eco5.com.)

- Rate of growth of total bank credit of commercial banks in the US (total loans and investments). This information can be downloaded from the Fed website

[6] It would have been better to add the real dividend per share to this percentage change in order to obtain the total stocks return. Unfortunately, this information was not available when this paper was being written.

(Series ID: H.8 Assets and liabilities of Commercial banks in the US). We call this variable, after discounting inflation, *bc*.

Preliminary Series Analysis

The first step in our analysis is to test for the order of integration of the series. We use Augmented Dickey-Fuller (ADF) and Phillips-Perron (P-P) tests. Table 1 shows the results. The Dickey-Fuller test requires prior knowledge of whether it is necessary to introduce deterministic components (intercept and/or trend) at the regression. For this purpose, we have used the strategy included in Dolado et al. (1990). We reject the unit root null hypothesis against the alternative hypothesis which states stationary (I(0)) for all the series considered[7].

Table 1. Unit Root Tests (H_0: unit root)

Variable	*ADF**	*Phillips-Perron*	*Order of integration*	*Critical Values***	*Intercept*	*Trend*
s	-10.78756 (*k*=0)	-10.80378	I(0)	-2.5763 (1% level) -1.9424 (5% level) -1.6157 (10% level)	No	No
g	-4.629358 (*k*=1)	-7.705463	I(0)			
p	-2.76744 (*k*=3)	-6.662742	I(0)			
bc	-3.313365 (*k*=2)	-7.046718	I(0)			
di	-3.662315 (*k*=1)	-3.4432186	I(0)			

* The numbers in brackets are the values of the autorregressive order *k* selected by the Hannan-Kinn Information Criterion.
** MacKinnon (1996).

We detected the presence of a structural break in various series included in this paper. In particular, both real long and short term interest rates (i^R_{LT} and i^R_{ST}, respectively) show structural changes (see time series graphs in Annex I).

Perron (1989) introduced the idea that any time series which has a structural change has a unit root using traditional tests (i.e. Dickey- Fuller) and when the structural break is incorporated into the test the series become stationary. Perron tried to incorporate the structural break into the traditional unit root test. Later, Zivot and Andrews (1992), and Ben-David y Pappell (1994), developed sequential tests to determine whether there was

[7] Although our initial aim was to estimate a co-integrated VAR model, the preliminary series analysis suggested that we could use the standard stationary model framework without the problem of spurious regressions, because all of the series are I(0).

a structural break in time series with no *a priori* restrictions on the series, and to test whether the series were stationary or not when the structural break was incorporated.

We perform a variety of unit root tests that are valid when breaks in the trend function of a time series are present, introduced by Zivot and Andrews (1992)[8]. Our objective is to estimate the following regression:

$$(4) \qquad \Delta y_t = \mu + \beta t + \gamma_1 DUM_t + \gamma_2 DUMT_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + u_t$$

for $t = 1,2,3,...,T$, where DUM_t and $DUMT_t$ are dummy variables for the intercept changes in the trend function, occurring at times T_A . $DUM_t=1$ if $t>T_A$ and 0 otherwise. $DUMT_t = t$ if $t>T_A$ and 0 otherwise. (Note that the only difference with ADF regression, including intercept and trend ones, is the inclusion of DUM_t and $DUMT_t$ variables). The null hypothesis stands for the presence of a unit root against the alternative of broken stationary-trend. The critical values are taken from Ben-David and Pappell (1994).

Table 2 shows the results of unit root tests in the presence of a structural change. The structural change break point, based on the Ben-David&Pappell strategy, occurs at 1981.03. This period corresponds with the Monetarist experiment during the Volcker era. We reject the unit root null against the alternative of broken trend stationary. Therefore, both i^R_{LT} and i^R_{ST} are stationary *I(0)*.

Table 2. Unit Root Tests in presence of a structural change (H_0: unit root)

Variable	*ADF**	*Order of integration*	*Critical Values***	*Intercept*	*Trend*
i^R_{LT}	-8.7113 (*k*=0)	I(0)	-2.5763 (1% level) -1.9424 (5% level) -1.6157 (10% level)	No	No
i^R_{ST}	-8.8381 (*k*=0)	I(0)			

* The numbers in brackets are the values of the autorregressive order *k* selected by the Hannan-Kinn Information Criterion.
** MacKinnon (1996).

4. REGRESSION RESULTS

Since conclusions, at the preliminary data analysis level, find that all of the time series included are stationary, our empirical relations have been estimated using the standard stationary model framework, with no problems of spurious regressions.

The first specification is a multi-equation system, with two equations, considering then two endogenous variables (i^R_{LT} and *s*, respectively):

[8] A recent paper on unit root tests in time series with structural changes can be found in Kim and Perron (2006).

(5) $$i^{R}_{LT_t} = \beta_0 + \beta_1 s_t + \beta_2 i^{R}_{ST_t} + \beta_3 p_t + \beta_4 g_t + \beta_5 bc_t + \beta_6 i^{R}_{LT_{t-1}} + v_t$$

(6) $$s_t = \delta_0 + \delta_1 i^{R}_{LT\,t} + \delta_2 i^{R}_{ST_t} + \delta_3 p_t + \delta_4 g_t + \delta_5 bc_t + \delta_6 s_{t-1} + \omega_t$$

In a multivariate regression model, the errors in different equations may be correlated. In this case, the efficiency of the estimation may be improved by taking these cross-equation correlations into account. For this purpose, we have used the *Three-Stage Least Squares* method (*3SLS*) to estimate our multi-equation system[9]. *3SLS* requires three steps: first-stage regressions to get predicted values for the endogenous regressors; a *2SLS* step to get residuals to estimate the cross-equation correlation matrix; and the final *3SLS* estimation step. Whether we use the *3SLS* method, it is hoped more efficient parameter than using *2SLS* method.

The main results are summarized in Table 3.

[9] The *3SLS* method generalizes the *Two-Stage Least Squares* method (*2SLS*) to take account of the correlations between equations in the same way that *SUR* (*Seemingly Unrelated Regression*) generalizes *OLS* (*Ordinary Least Squares*). The main different between each pair of models (*SUR* and *OLS*, and *3SLS* and *2SLS*) is that instrument and endogenous variables are not differenced at the former, but these information are useful in the other pair of estimation methods.

Table 3. Regression analysis (*Three-Stage Least Squares Estimations*)										
	Model 1		***Model 2***		***Model 3***		***Model 4***		***Model 5***	
	Eq5.1	***Eq 6.1***	***Eq 5.2***	***Eq 6.2***	***Eq 5.3***	***Eq 6.3***	***Eq 5.4***	***Eq 6.4***	***Eq 5.5***	***Eq 6.5***
Dep. Var.⇒ / *Exog. Var.*⇓	i^R_{LT}	s_t	i^R_{LT}	s_t	i^R_{LT}	s_t	i^R_{LT}	s_t	i^R_{LT}	s_t
C	0.0128 (4.68)	0.0212 (1.65)	0.0007 (2.09)	-0.0164 (-3.48)	0.0015 (1.72)	-0.0048 (-0.69)	0.0015 (1.78)	0.0292 (2.19)	0.0020 (2.05)	
$i^R_{LT(t)}$		1.1287 (4.43)		1.5859 (6.66)		1.1346 (4.58)		1.0977 (4.43)		2.0760 (8.60)
$i^R_{LT(t-1)}$	-0.0025 (-0.43)									
s_t	0.0008 (0.98)		0.0085 (2.20)		0.0051 (2.91)		0.0056 (3.17)		0.0068 (3.72)	
s_{t-1}			0.0122 (3.41)		0.0082 (4.64)		0.0086 (4.91)		0.0073 (3.88)	
s_{t-2}			0.0066 (1.95)		0.0059 (3.61)		0.00609 (3.63)		0.0056 (3.21)	
$i^R_{ST(t)}$	0.2909 (9.54)		0.8848 (39.92)		0.9289 (63.99)		0.9286 (63.94)		0.9760 (91.68)	
$i^R_{ST(t+1)}$		-1.8027 (-2.45)						-2.3694 (-3.10)		-0.3434 (-1.54)
p_t	-0.6959 (-21.66)									
p_{t+1}		-1.6890 (-2.30)						-2.2307 (-2.93)		
Δp_t										1.0332 (4.57)
g_t	-0.0068 (-1.07)	0.6444 (2.10)		1.7542 (4.91)		0.7664 (2.41)		0.6687 (2.19)	0.0157 (1.31)	0.5239 (1.90)
g_{t+1}			0.0697 (2.84)		0.0255 (2.26)		0.0254 (2.24)			
bc_t	0.0049 (0.64)		0.1150 (5.29)		0.0589 (4.61)		0.0585 (4.58)			
Δs_t		0.4731 (17.04)		0.4781 (11.75)		0.4761 (16.54)		0.4725 (16.97)		0.5024 (18.41)
AR(1)[10]	0.9747 (62.03)	0.5693 (8.70)			0.8730 (24.65)	0.5504 (8.31)	0.8683 (24.53)	0.5773 (8.72)	0.9511 (59.76)	0.5882 (9.48)
Adj. R^2	0.9953	0.6635	0.9500	0.5252	0.9870	0.6522	0.9870	0.6640	0.9954	0.68
DW	-	1.66	0.37	1.06	1.80	1.63	1.79	1.66	1.78	1.55
h-Durbin[11]	0.15	-	-	-	-	-	-	-		

Interpretation:

Let us begin with the long term real interest rate.

- It parallels the short term real interest rate. The regression parameter is always positive, with a corresponding t-statistic showing high values. However, changes in the short term rate are not completely shifted to the long real rate.
- There is some evidence to support the relevance of arbitrage on the long term real rate, as the regression parameter of s is positive and with a t-statistic greater than 2 in equations 5.2-5. It should be noted, however, that the value of the

[10] It is necessary to include an autorregresive process (AR(1)) to correct autocorrelation problems. For this purpose, we estimate the ρ parameter in the AR(1) process: $u_t = \rho u_{t-1} + \varepsilon_t$.

[11] When the regression includes lagged dependent variables, the Durbin-Watson statistic (*DW*) is not valid as a test for auto-correlated residuals. *DW* tends to be biased towards 2. Durbin *h* statistic (*h-Durbin*) should be used instead. For "large samples" *h-Durbin* has a standard normal distribution. Therefore, for a test of the null hypothesis of no autocorrelation against the alternative of auto-correlated errors, at a 5% level, the decision rule is if *-1.96<h<1.96* do not reject the null hypothesis.

regression parameter is rather small. Also, lagged values of *s* are positively correlated with the long term real interest rate and statistically significant.

- The rate of growth of output with one lead or one lag is positively correlated with i^R_{LT} and significant (eqs. 5.2-3-4). However, the current output rate is positively correlated though non-significant (eqs. 5.1 and 5.5).
- Inflation affects i^R_{LT} negatively. Increases in inflation are usually followed by increases in the long term nominal interest rate. However, they are not enough to lead to increase the real long rate.
- The rate of growth of bank credit is positively correlated with i^R_{LT}.
- The adjusted R^2 shows high values, so the model encapsulated in models 1-5 is acceptable for the long term real interest rate.
- The h-Durbin statistic lies between -1.96 and 1.96, in eq. 5.1 so autocorrelation can be ruled out. Also, the D-W is nearly 1.8 for equations 5.3-4-5. The reader may observe that models 2 and 3 are the same, but the later includes an AR(1). This eliminates the problem of autocorrelation in model 2 (where the D-W is 0.37 in equation 5.2).

Secondly, with regard to the percentage change of S&P-500 (*s*):

- Current i^R_{LT} is positively correlated with *s*.
- One lead i^R_{ST} is negatively correlated with *s*.
- We interpret inflation with one lead as expected future inflation, i.e. agents make no errors in their predictions. Then, expected inflation has a negative effect on *s*. This impact may occur for two reasons: (i) increases in commodity prices are not completely shifted towards stock prices, and (ii) increases in commodity prices lead agents to expect future increases in short term interest rates. However, current changes in inflation are positively correlated with *s* (eq. 6.5).
- Current output growth is positively correlated with *s*.
- Contrary to Lavoie and Secareccia, 2004, we find no evidence to support causality running from the interest rates towards stock prices. Equations 5.2-3-4 point to some causality running the other way around: from the S&P 500 towards the long term real interest rate, since the regression parameters for

- The adjusted R^2 lies between 0.65 and 0.68 (except for equation 6.2 which includes a problem of autocorrelation), so it can be concluded that the specification of the model is missing some relevant .

In order to investigate the causal effects of set of variables on long-term and short-term interest rate gap, a single equation model is constructed, following the next initial specification:

(7) $$di_t = \alpha_0 + \alpha_1 s_t + \alpha_2 i^R_{ST_t} + \alpha_3 p_t + \alpha_4 g_t + \alpha_5 bc_t + \alpha_6 di_{t-1} + \varepsilon_t$$

The main results are summarized in **¡Error! No se encuentra el origen de la referencia.**.

Table 4. Regression analysis

	Eq 7.1	*Eq 7.2*	*Eq 7.3*	*Eq 7.4*	*Eq 7.5*
Dep. Variable⇒ / *Exog. Variable*⇓	*di*	*di*	*di*	*di*	*di*
c	0.0018 (4.39)	0.0018 (5.31)	0.0014 (3.90)	0.0005 (2.93)	0.0001 (0.86)
s_t	0.0040 (1.98)	0.0046 (2.35)	0.0027 (1.36)		
$i^R_{ST(t)}$	-0.0724 (-3.72)	-0.0801 (-4.28)	-0.0702 (-3.75)		
$i^R_{ST(t-1)}$					0.0275 (3.07)
p_t	-0.0958 (-4.55)	-0.0954 (-4.94)	-0.0885 (-4.62)		
p_{t+1}				-0.0186 (-2.10)	
g_t	0.0001 (0.01)				
g_{t+1}			0.0415 (2.98)		
bc_t	-0.0050 (-0.38)				
di_{t-1}	0.7611 (17.89)	0.9504 (14.00)	0.9273 (13.82)	1.0380 (15.01)	1.0376 (15.28)
di_{t-2}		-0.2263 (-3.49)	-0.2190 (-3.44)	-0.1857 (-2.70)	-0.1667 (-2.44)
Δs_t				0.0041 (2.43)	0.0045 (2.78)
Δs_{t-1}				0.0055 (3.10)	0.0047 (2.59)
Δs_{t-2}				0.0050 (3.00)	0.0044 (2.68)
Adj. R^2	0.7966	0.8104	0.8183	0.7940	0.7991
DW	-	-	-	-	-
h-Durbin	4.17	2.05*	2.49*	-2.09*	-2.43*

* Do not reject the null hypothesis (no autocorrelation) at the 1% level of significance (critical value = 2.57)

The Durbin's h test from regression 7.1 suggests that positive serial correlation is present. In addition, there are various parameters no statistically significant. Nevertheless, in the rest of models we see that stock prices affect positively to the interest gap output growth increases this gap and the regression parameter for inflation is negative.

Finally, we proceed to study causality, using the Granger Causality Test. The results are shown in Table 4. There is no evidence that the growth rate of S&P500 (*s*) Granger causes the real long term interest rate i^R_{LT} but, on the contrary, i^R_{LT} causes *s*. However, if we use monthly dates, there is strong evidence that *s* Granger causes i^R_{LT} (Granger test = 17.9891 for the first lag). Also, when we use the second, third and even the fourth lag some evidence about causality from *s* to i^R_{LT} appears.

The percentage change of S&P500 Granger causes the long term and short term interest rate gap *(di)* but *di* does not cause *s*. And inflation (*p*) Granger causes *di*.

We find some evidence that changes in GDP growth rate and the long term interest rate gap ($[g_t - i^R_{LT(t)}]$) cause changes in the Growth Rate of S&P500 *(s)* when we consider both variables at current time. Also, when we use the first, second and even the third lag for $[g_{t-i} - i^R_{LT(t-i)}]$ some evidence about causality with *s* appears.

On the other hand, there appears to be strong evidence of a two-way Granger causality, for different lag lengths, when we perform the direction of causality between *g* and *di*.

Table 4. Granger Causality Tests					
Null hypothesis (Ho):	*Granger test*	*Reject Ho*	*Lag length*	*Critical values* 5% significance level	*Critical values* 1% significance level
i^R_{LT} does not Granger cause *s*	5.3235	Yes (5% level)	*k*=1	3.89	6.76
s does not Granger cause i^R_{LT}	0.8349	No			
di does not Granger cause *s*	0.9212	No	*k*=1	3.89	6.76
s does not Granger cause *di*	5.0677	Yes (5% level)			
di does not Granger cause *p*	0.6482	No	*k*=1	3.89	6.76
P does not Granger cause *di*	16.9893	Yes			
$[g - i^R_{LT}]$ does not Granger cause *s*	5.0133	Yes (5% level)	*k*=1	3.89	6.76
s does not Granger cause $[g - i^R_{LT}]$	5.8393	Yes (5% level)			
$[g_{t-1} - i^R_{LT(t-1)}]$ does not Granger cause *s*	5.2041	Yes (5% level)	*k*=1	3.89	6.76
s does not Granger cause $[g_{t-1} - i^R_{LT(t-1)}]$	8.9034	Yes			
$[g_{t-2} - i^R_{LT(t-2)}]$ does not Granger cause *s*	7.2264	Yes	*k*=1	3.89	6.76
s does not Granger cause $[g_{t-2} - i^R_{LT(t-2)}]$	3.9550	Yes (5% level)			
$[g_{t-3} - i^R_{LT(t-3)}]$ does not Granger cause *s*	5.2658	Yes (5% level)	*k*=1	3.89	6.76
s does not Granger cause $[g_{t-3} - i^R_{LT(t-3)}]$	2.7380*	No			
di does not Granger cause *g*	23.4760	Yes	*k*=1	3.89	6.76
G does not Granger cause *di*	5.7848	Yes (5% level)			
di does not Granger cause *g*	13.8755	Yes	*k*=2	3.04	4.71
G does not Granger cause *di*	6.1718	Yes			

* Reject *Ho* at the 10% level of significance (critical value=2.73).

5. CONCLUSIONS

In this paper we have attempted to test the validity of an alternative interpretation of Wicksell's contribution, as suggested by Nell. The rate of growth of output affects the rate of change of stock prices positively, whilst the short term interest rate works in the opposite direction. The long term real interest rate follows the short term real rate but it is also affected, through arbitrage, by stock prices. Thus, the central bank only has a limited capacity to control the long term real interest rate. Additionally, the rate of growth of output is not completely exogenous: it is affected by the long term real interest rate. However, we have been unable to find a concrete threshold (short term, real) interest rate, relative to output growth, which makes stock prices rise or fall.

REFERENCES

Ben-David, D. and Pappell, D.H. 1994: "The great wars, the great crash, and the unit root hypothesis: some new evidence about an old stylized fact", *NBER Working Paper*, no. 4752.

Dolado, J., Jenkinson, T. and Sosvilla-Rivero, S. 1990: "Cointegration and Unit Roots: a Survey", *Journal of Economic Surveys*, 4 (3), pp. 249-273.

Kaldor, N. 1956: "Alternative Theories of Distribution", *Review of Economic Studies*, 23, pp. 83-100.

Kim, D. and Perron, P. 2006: "Unit Root Tests Allowing for a Break in the Trend Function at an Unknown Time Under both the Null and Alternative Hypotheses", *Boston University Working Paper*, March, 2006.

Kindleberger, C. 1989: *Manias, panics and crashes, a history of financial crises*, Spanish version in Barcelona: Ariel.

Lavoie, M. and Secareccia, M. 2004: "Long-Term Interest Rates, Liquidity Preference and the Limits of Central Banking" in M. Lavoie and M. Secareccia (eds.) *Central Banking in the Modern World. Alternative Perspectives*, Cheltenham: Edward Elgar.

Nell, E.J. 1998: *The General Theory of Transformational Growth*, Cambridge: Cambridge University Press.

Nell, E.J. 1999: "Wicksell after Sraffa. 'Capital arbitrage' and 'normal' rates of growth, interest and profits", in G. Mongiovi and F. Petri (eds.) *Value, Distribution and Capital. Essays in honour of Piergangelo Garegnani*, London: Routledge.

Pasinetti, L.L. 1974: *Growth and Income Distribution*, Cambridge: Cambridge University Press.

Perron, P. 1989: "The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis", *Econometrica*, 57, pp. 1361-1401.

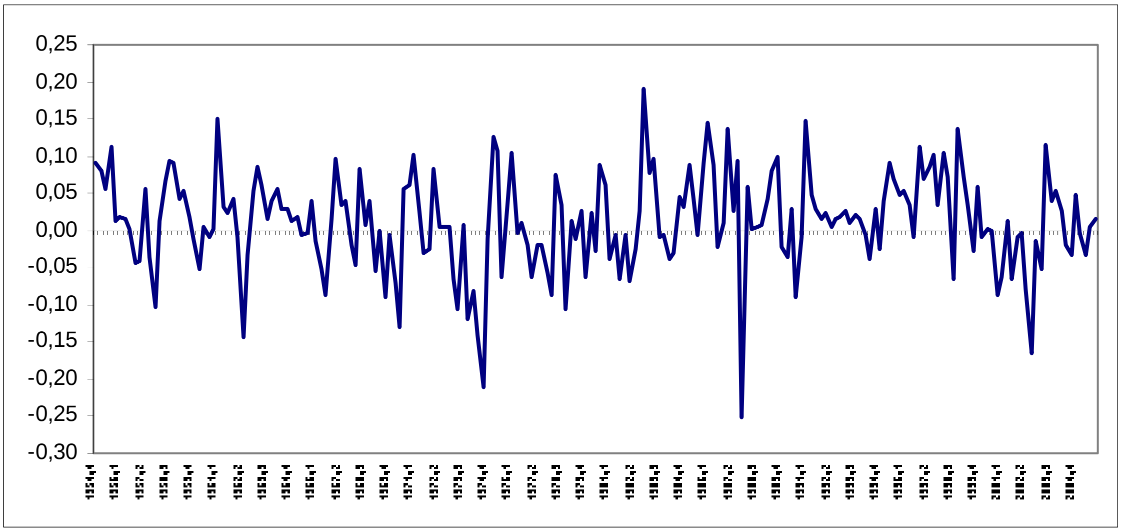
Wicksell, K. 1898: *Interest and prices*, Spanish version in Madrid: Ed. Aosta.

Wicksell, K. 1907: "The Influence of the Rate of Interest on Prices", *Economic Journal*, 17, pp. 213-220.

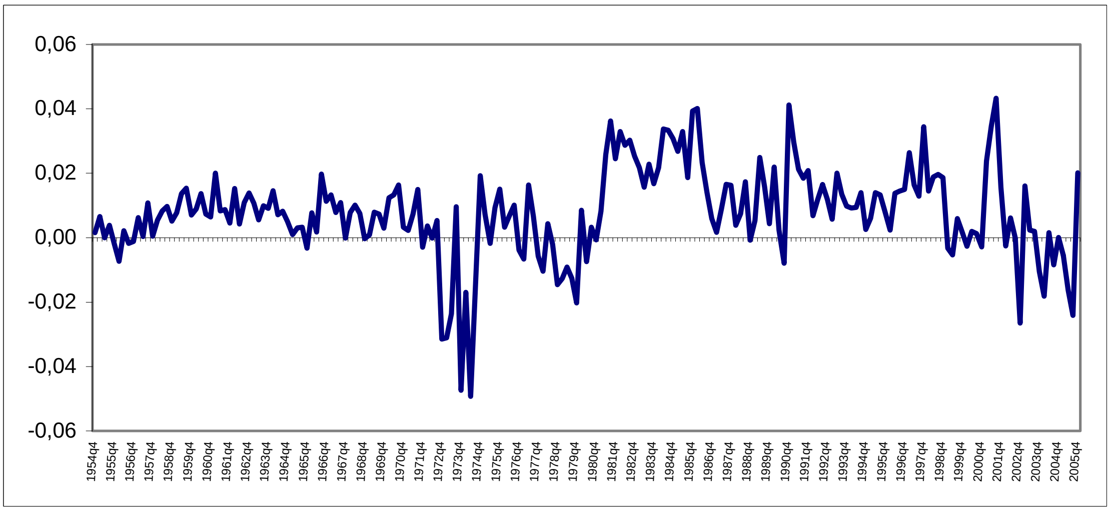
Zivot, E. and Andrews, D. 1992: "Further evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis", *Journal of Business & Economics Statistics*, 10 (3) pp. 251-270.

Annex 1: Figures

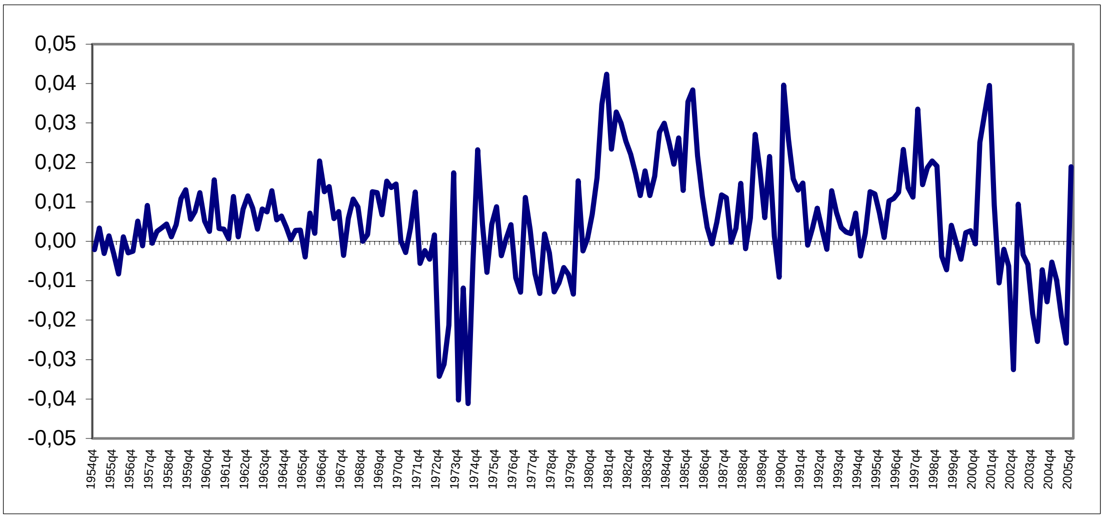
Graph 1. Growth Rate of Standard & Poor 500



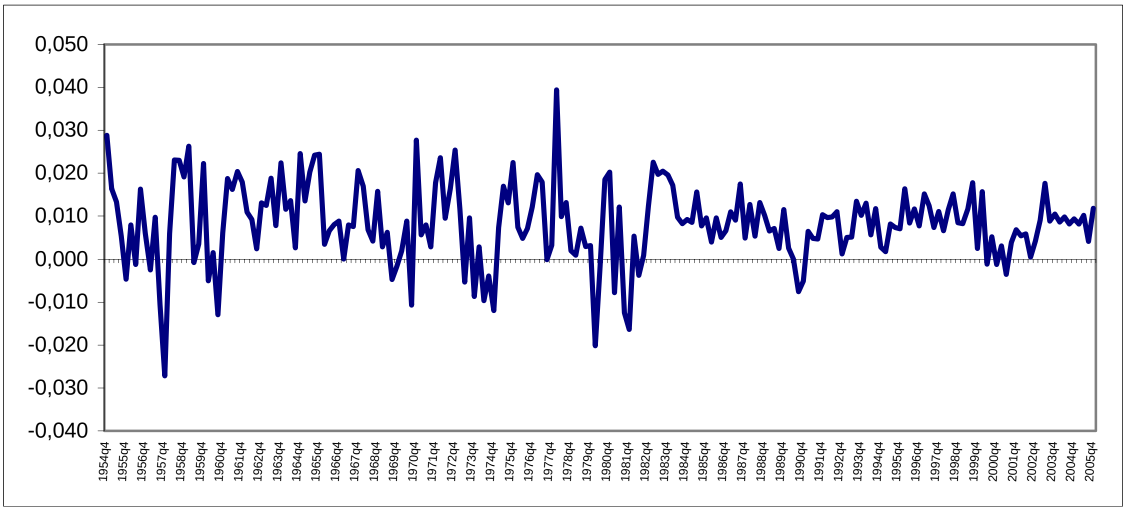
Graph 2. Real Long-Term Interest Rate



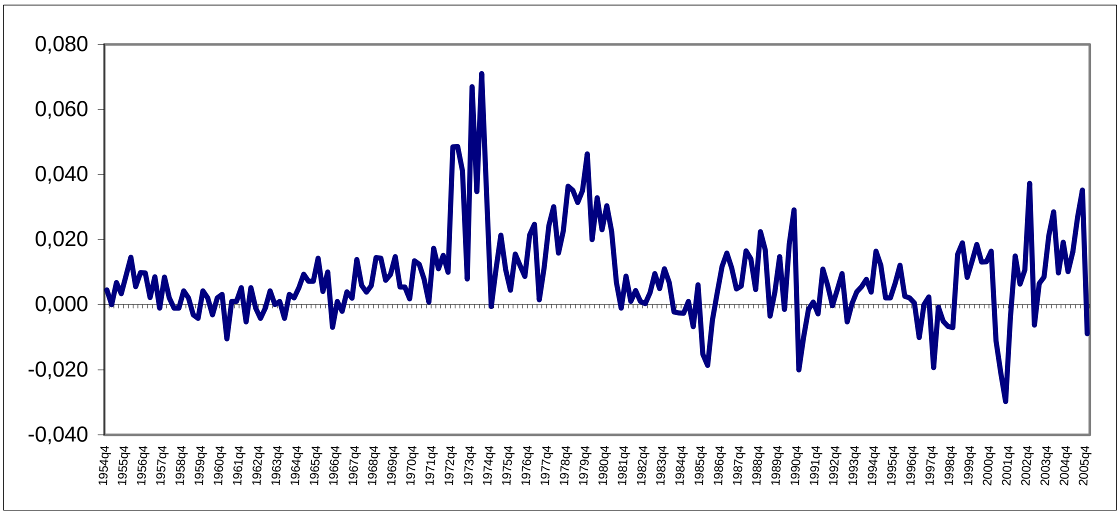
Graph 3. Real Short-Term Interest Rate



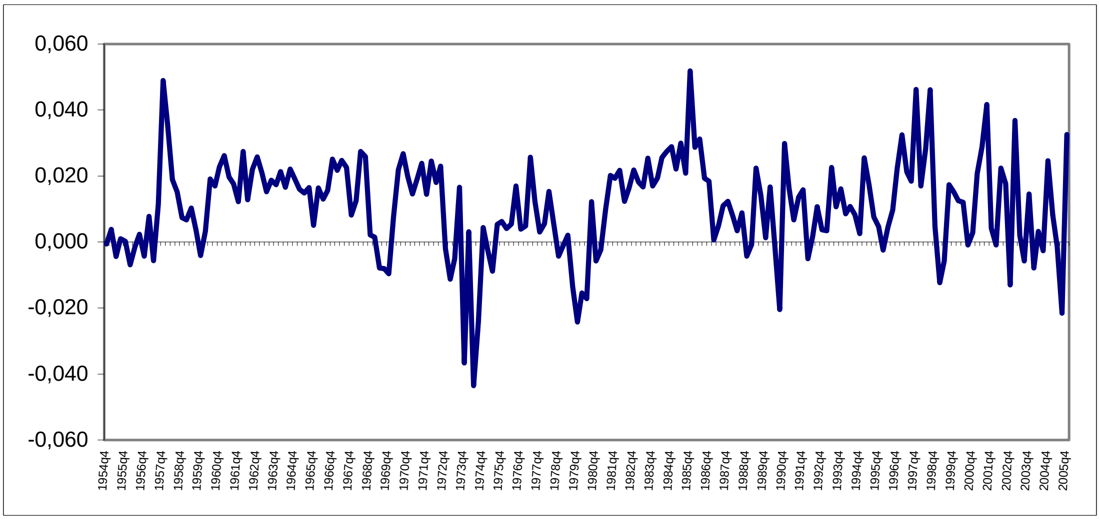
Graph 4. Real GDP Growth Rate



Graph 5. Inflation



Graph 6. Growth Rate of Banking Credit



Graph 7. Long-Term and Short-Term Interest Rate Gap