Structural Breaks, Inflation and Interest Rates: Evidence for the G7 countries*

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January 2004

Abstract

This paper challenges the commonly used unit root/cointegration approach for testing the Fisher effect for the economies of the G7 countries. We first prove that nominal interest and inflation rate can be better represented as being broken trend stationary variables. Later, we use the Bai-Perron procedure to show the existence of structural changes in the Fisher equation. When these characteristics are taken into account the Fisher hypothesis we can only offer evidence in favor of this hypothesis for the US, the French and the Japanese economies.

- JEL Codes: C22; E43
- Keywords: Unit Roots; Structural Breaks; Interest rates; Inflation; Fisher Effect.

*The authors acknowledge the financial support of the DGES under project BEC2001-2561 and that of the consolidated group ADETRE. The usual disclaimer applies.
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1 Introduction

One of most important results of classical economic theory is that the movements of nominal variables have no impact on real economic variables. This result, which can be verified by testing the long-run neutrality proposition, implies that a permanent movement in the inflation rate has no effect on the equilibrium real interest rate. The traditional way to represent this phenomenon is to decompose nominal interest rates into two separate components that reflect the expected inflation, on the one hand, and the "real" interest rate, on the other. Following the very influential work of Fisher (1930), this relationship can be stated through the well-known Fisher equation:

$$R_t = \pi_t^e + r_t \tag{1}$$

where R represents the nominal interest rate, π^e is the expected rate of inflation and r is the (*ex-ante*) real interest rate. In simple economic models, this last variable is determined by deep structural parameters, such as investor preferences or the marginal efficiency of capital, and is often assumed to be constant over long horizons. According to (1), money lenders need a nominal interest rate that compensates them for the loss of purchasing power during the duration of the loan, with this compensation being proxied by the expected inflation. Thus, if we admit that there is no money illusion, then a change in the expected inflation rate should be fully transmitted to the nominal interest rate in order for the real interest rate to remain constant.

The information that (1) provides is quite useful both for theoretical researcher, as well as for taking economic policy decisions. For example, if the Fisher effect holds, then the expected inflation is a good predictor of the nominal interest rate. Further, evidence in favor of the superneutrality of money hypothesis is found. Consequently, it comes as no surprise that a huge volume of literature has directed its efforts towards the analysis of the relationship between nominal interest rates and inflation or, more exactly, towards whether the so-called Fisher effect holds. The most common approach starts by estimating the following equation:

$$R_t = \alpha + \beta \pi_{t+1} + e_t \tag{2}$$

where the presence of perfect rational expectations ($\pi_{t+1} = \pi_t^e$) is implicitly assumed. It is clear that whenever the value of the parameter β, often referred to as the Fisher parameter, is equal to 1, this equation is equivalent to (1) and, therefore, we should conclude that the Fisher effect holds. At first sight, the analysis of this effect would appear to be quite straightforward, in the sense that it only requires the estimation of model (2) and, subsequently, the testing of the null hypothesis H_o: $\beta = 1$. However, the literature confirms that there are several points which should be taken into account in order to accurately estimate this parameter and test for this hypothesis. Here, we are thinking in terms of the appropriate treatment of the time series properties of the variables, as well as the possible presence of changes in the values of the parameters α and, β, and, finally, the inclusion of dynamic effects. In this paper, we consider the relevance of all these points.

With the respect of the first point, there seems to be an almost unanimous opinion in the literature that favors the existence of unit roots in both the nominal interest and the inflation rates. Therefore, "standard" econometric models are not longer valid; rather, the cointegration approach should be employed. We can cite several examples of the use of this unit root/cointegration approach, beginning with the seminal papers of Rose (1988) or Mishkin (1992), whose methodology has subsequently been applied in the more recent works of Crowder and Wohar (1999), Koustas and Serletis (1999), Rappach (2002) or Laatschs and Klein (2002), amongst many others. Nevertheless, other recent contributions, such as those of Malliaropoulos (2000), Lanne (2001), Olekalns (2001), Gil-Alaña (2002) or Atkins and Coe (2002), have questioned the use of such an approach. These latter authors consider that neglecting the possible presence of structural breaks in the evolution of both the nominal interest rate and the inflation rate might bias the result of unit root tests towards the failure of rejection the unit root null hypothesis. Thus, the use of the cointegration approach is nowadays being seriously questioned.

The second point concerns the constancy of the parameters. In this regard, a simple review of the literature leads us to conclude that most of the studies consider the parameters of the model (2) to be constant. This assumption is somewhat naive, in the sense that it does not correspond to what occurs empirically, especially if we take into account that these studies use sample sizes which cover the period running from the 1970's to the present day. We need only reflect on the different monetary policies applied during this very lengthy period of time in order to realize that the validity of the constant parameters hypothesis is dubious. By contrast, we would argue that it is more sensible to advance the hypothesis that the Fisher relationship may be affected by the presence of some structural breaks. Their presence can be easily understood if we take into account that, for example, the real interest rate is the consequence of the interaction between savings and investment, in such a way that this rate may change when savings owners modify their behavior. In this regard, and as Chadha and Dimsdale (1999) point out, demographic change, technological progress, fiscal incentives, changes in the taxation of profits, the size of the public debt, the investors' perception of risk and the degree of regulation or deregulation of capital markets could alter the constant and the inflation parameter. Another source of the possible variation of the parameters of model (2) comes from the fact that the influence of inflation on the nominal interest rate can also vary. In this line, more robust inflation targeting and a more active monetary policy, see Söderlind (2001) and Olekalns (2001), or constraints on capital markets could be important determinants of the final value.

The third and final point concerns the presence of dynamic effects where, it should be noted, the influence of the inflation rate on the nominal interest rate may not simply be a contemporary phenomenon. Rather, the existence of such dynamic effects, which act on the generation of expected inflation or on the existence of persistence in the evolution of the nominal interest rate, should also be considered. This is the reason why a number of papers, such as Fahmy and Kandill (2002) or Atkins and Coe (2002), analyze the Fisher effect from a dynamic perspective.

Against this background, the goal of this paper is to show that most of the previous studies dedicated to analyzing the Fisher effect have not in fact done so in an appropriate manner, given that they have failed to properly reflect one or all of the three criticisms. More particularly, we demonstrate that the methodologies previously employed are not capable of providing us with useful results in order to better understand the relationship between the nominal interest rates and the inflation rates of the G7 countries. In order to prove this starting hypothesis, we should begin by appropriately testing the time series properties of these different nominal interest and inflation rates. In our view, the use of those unit root tests which allow for the presence of some structural breaks is crucial. Thus, if we can prove that these variables are better characterized as being (broken) trend stationary, then we should not use the cointegration approach. Moreover, and using similar arguments to those employed in Malliaropoulos (2000), we could also show that this approach may lead us to spuriously accept the Fisher effect. Following this strategy, and in order to reflect the second of the above criticisms, we should allow for the presence of some breaks in the relationship between the nominal interest rates and inflation rates. In a stationary scenario, we can apply the procedure proposed in Bai and Perron (1998, 2003) to test for the stability of the Fisher effect equation. This method also has the advantage of being able to provide us with consistent estimations of both the number of breaks and the periods when these occur. Finally, we can use the results obtained from applying these techniques to estimate the Fisher relationship when the structural breaks and the dynamic effects are also incorporated.

The rest of the paper is organized as follows. In Section 2 we describe the tests we employ. When applied to the nominal interest and inflation rates of the economies of the G7 countries, we find that they allow us to robustly reject the unit root null hypothesis and accept the stationarity null hypothesis. This is the main finding of the paper, in that it invalidates any result obtained from the application of the cointegration approach to the analysis of the Fisher effect. Thus, an alternative methodology is clearly required and, in response, we propose a strategy based on the use of trend stationary variables and on the existence of some breaks in the relationship between the nominal interest and the inflation rate. Section 3 is devoted to a discussion of this proposed strategy, as well as to a consideration of the results obtained when it is applied to the economies of the G7 countries. Section 4 closes the paper with a review of the most important conclusions

2 Nominal interest rates, inflation rates: unit roots versus trend stationarity

Following the seminal paper of Nelson and Plosser (1982), most of the empirical analyses based on the use of variables measured as time series begin studying the time properties of the variables. If these variables are better characterized as being integrated, then cointegration techniques are used. If, by contrast, they are considered as being stationary, then "standard" econometric techniques can be employed. The study of the Fisher effect is a scenario where we can clearly appreciate the application of this strategy and, ever since the appearance of the classic paper of Mishkin (1992), most of this literature has followed this pattern.

However, some much more recent papers have cast a number of serious doubts on the appropriateness of the unit root model when seeking to accurately describe the evolution of both inflation and nominal interest rates. In this regard, we can cite Malliaropoulos (2000) or Baum et al. (1999), where it is shown that US nominal interest and inflation rates can be better represented by way of broken trend stationary models. This finding is very important in the sense that, at least for the US data, it invalidates the use of the cointegration approach as an appropriate way to test for the Fisher effect. By way of illustration, under this approach a very commonly applied method is to test whether the real interest rate is integrated: if we can conclude that this real interest rate is stationary, this should be interpreted as evidence in favor of the Fisher effect. However, this method is only valid whenever the nominal interest and the expected inflation rate are integrated and, in other circumstances, it is not accurate. To better appreciate this, let us consider that expected inflation (π) and the nominal interest rate (R) can be considered as (broken) trend stationary variables. Any combination of these variables, say $R- \beta \pi$, will also be a trend break variable and, therefore, we should observe that the real interest rate is also stationary. However, this does not imply that the Fisher effect holds, in that it only does so when the parameter β is 1. Thus, under these circumstances, to admit that the real interest rate is stationary does not necessarily imply that the Fisher effect holds.

Such a finding requires a careful analysis of the time properties of the nominal interest and inflation rates, which the aim of the next subsection.

2.1 Analysis of the Time Properties of the Nominal Interest and Inflation rates

As we have mentioned earlier, the analysis of the time properties of the nominal interest and inflation rates should be treated carefully, and should certainly not be regarded as a mere prior step to the use of cointegration techniques. We dispose of a great range of statistics devoted to this issue. For example, most relevant papers base their analysis on the use of the Augmented Dickey-Fuller tests (Dickey and Fuller, 1979, and Said and Dickey, 1984) or those presented in Phillips and Perron (1988). In this regard, we should particularly note the recent paper of Ng and Perron (2001), which compares the performance of a wide range of unit root statistics. From amongst a number of available statistics, these authors propose the ADF^{GLS} [1], which is based on the very popular ADF test. This can be obtained from the estimating the following model:

$$y_t = \mu + \gamma t + \rho y_{t-1} + \sum_{i=1}^{k} \phi_i \Delta y_{t-i} + \varepsilon_t \tag{3}$$

and subsequently calculating the pseudo t-ratio for testing whether the parameter ρ is 1. The differences between this and the simple ADF lie in the fact that ADF^{GLS} is based on the use of GLS estimation methods, instead of OLS estimators, and on the determination of the value of the lag truncation parameter via the use of an information criterion, called MIC, also proposed in Ng and Perron (2001).

In some cases the use of this statistic may not be appropriate: for example, if we can admit that the variable being studied may present some structural breaks that affect to the deterministic elements. In this case, the distortions caused by the omission of these breaks on the unit root inference has been

[1] Ng and Perron (2001) also consider alternative tests, based on modifications of the Phillips-Perron statistics. However, their use does not modify the conclusions that we have obtained with the ADF^{GLS} and, therefore, we have chose to omit these results.

very well documented in, amongst others, Perron (1989) or in Montañés and Reyes (1998). Given that the nominal interest and inflation rates may exhibit this kind of behavior, these breaks should clearly be included in the model specification. To that end, we should first take into account that we can find several types of breaks. For example, we can admit the possibility that these breaks only affect the intercept of the trend polynomial, or only the parameters associated to the trend or, the most common case, both the intercept and the slope. Secondly, we should consider that the presence of a single break cannot be enough to capture the evolution of the variables being studied. Thus, it seems to be advisable to consider the presence of more than one break. Here, in order to take into account the possible presence of these breaks, we could extend the equation (3) by including some dummy variables that can capture the effect of these changes on the deterministic elements. In fact, this approach is followed by Perron (1989), when the period when the break appears is exogenously determined, and by Perron and Vogelsang (1998), Zivot and Andrews (1992) or Lumsdaine and Papell (1997), when this period is endogenously determined by the model.

As an alternative to this *à la Perron* methodology, Lee and Strazicich (2002a, 2002b) have recently proposed a somewhat different approach that is based on the LM (score) principle. Following the paper of Schmidt and Phillips (1992), these statistics can be obtained by estimating the following model:

$$\Delta y_t = \delta' \Delta Z_t + \phi \tilde{S}_{t-1} + u_t \tag{4}$$

where Z_t reflects the deterministic components, $\tilde{S}_t = y_t - \tilde{\psi}_x - Z_t \delta$, $t = 2, 3, ..., T$, are coefficients in the regression of Δy_t on ΔZ_t, $\tilde{\psi}_x$ is given by $y_1 - Z_1 \tilde{\delta}$ (see Schmidt and Phillips, 1992, in this regard), and y_1 and Z_1 denote the first observations of y_t and Z_t, respectively. The unit root null hypothesis is described by $\phi = 0$ and can be tested by way of a pseudo t-ratio statistic that we will denote as $\tilde{\tau}$. When $Z_t = \{1, t\}$, then we have the statistic proposed in Schmidt and Phillips (1992). If we want to account for some structural breaks, we should simply reflect them in Z_t. Thus, for example, we can consider the case where the breaks may affect both the intercept and the slope of the trend by simply assuming that $Z_t = \{1, t, D_1, ..., D_n, DT_1, ..., DT_n\}$, where $D_{it} = 1$ if $t > TB_i$ and 0 otherwise, whilst $DT_i = t\, D_{it}$, with $TB_i = \lambda_i T$ being the period of time where the $i-th$ break appears and $i = 1, 2, ..., n$. We will denote this statistic as $\tilde{\tau}_n^{CC}$, where the sub-index n reflects the number of breaks considered and the super-index CC indicates that we are allowing for a change in the intercept and in the slope.

Lee and Strazicich (2002a, 2002b) have derived the asymptotic distribu-