Are exchange rates really free from seasonality? An exploratory analysis on monthly time series

Cellini, Roberto and Cuccia, Tiziana

University of Catania, DEMQ, University of Catania, DEMQ

11 May 2011

Are exchange rates really free from seasonality? An exploratory analysis on monthly time series

Roberto Cellini and Tiziana Cuccia

Department of Economics and Quantitative Methods, University of Catania
Corso Italia, 55- 95129 Catania – Italy
Tel. +39 095 7537728 ; Fax +39 095 7537710
e-mail: cellini@unict.it ; cucciati@unict.it

Abstract: This article questions the assumption that exchange rates are non-seasonal and provides selected evidence of monthly time series of exchange rates in which significant seasonal components are present. However, the seasonal component appears to be absent in more recent data. Tentative explanations are suggested.
JEL Classification: C22, F31.
Keywords: Seasonality, Exchange rates.

Running title: Are exchange rates really free from seasonality?

Corresponding Author: Roberto Cellini
c/o Department of Economics and Quantitative Methods, University of Catania
Corso Italia, 55- 95129 Catania – Italy
Tel. +39 095 7537728 ; Fax +39 095 7537710
e-mail: cellini@unict.it

Are exchange rates really free from seasonality? An exploratory analysis on monthly time series

Abstract: This article questions the assumption that exchange rates are non-seasonal and provides selected evidence of monthly time series of exchange rates in which significant seasonal components are present. However, the seasonal component appears to be absent in more recent data. Tentative explanations are suggested.

JEL Classification: C22, F31.

Keywords: Seasonality, Exchange rates.

1. Introduction

A huge body of theoretical and empirical literature studies the pattern of exchange rates and their determinants at different frequencies. In this article, we focus on monthly time series. The available literature takes for granted that exchange rates observed with a monthly frequency exhibit no seasonality and integration of order 1 (see, e.g., Jiménez-Martin and Flores de Frutos, 2009).

The absence of seasonality appears to be a sort of puzzle because the determinants of exchange rates show a great deal of seasonality if examined with a monthly frequency: consider money supply, interest rates, consumption expenditures, and so on. The explanation generally provided is as follows. Agents know that fundamental macroeconomic variables present seasonal variation, but they like to limit the seasonality of exchange rates, if possible, to limit the noise in price signals in the economic system. Smoothing the dynamics of exchange rates and preventing exchange rates from fluctuating seasonally are possible thanks to appropriate behaviors in capital and good markets. Agents can thus reach welfare-improving results (Miron, 1986; see also Meese and Rogoff, 1988, and Grilli and Roubini, 1992). If so, we should expect that financial market integration (and sophistication) entails more limited seasonal variation of exchange rates thanks to an increased possibility of financial smoothing. To check this point, we focus on selected bilateral exchange rates observed over periods between January 1974 and December 2010 (US dollar, German mark, Italian lira, Japanese yen, British pound, till to Euro, are considered). The evidence only partially confirms expectations.

In particular, we find that the exchange rates are far from being free from seasonality, broadly speaking. Seasonality is present in several cases, admittedly, concerning data from the decades of the Seventies and Eighties of the 20th century, whereas no seasonality emerges for more recent periods. This result could suggest that the increased financial integration of recent decades and the Euro's integration have indeed permitted a broader process of exchange rate smoothing over months.

2. Data and test for seasonality

In what follows, we consider monthly time series of bilateral nominal exchange rates. Each observation is the monthly average value of daily rates as provided by the European Central Bank.[1] For each of the considered monthly time series, we provide the following tests:

1) the F-test for evaluating the presence of stable seasonality, F_S; essentially, this test is based on the quotient of two variances: the between-month variance and the residual variance. The acceptance of the null hypothesis means that no seasonal variability is present in the data;
2) the Kruskall-Wallis statistic, K, which evaluates the equality of median values across different months (a value of this statistic falling into the rejection region means that median values are not constant across months);
3) the F-test for evaluating the presence of moving seasonality, F_M; this test (see, e.g., Higgison, 1975) is applied to the sum of the seasonal and irregular components of the time series (that is, the series without trend and cyclical components) and is based on the quotient of two variances, the variance between years and the residual variance. A test value falling in the rejection region means that the seasonal-irregular component of the series is not stable across years.

All of the mentioned tests are computed by the X-12-ARIMA program, which is the program provided by the US Census Bureau for evaluating (and disentangling) the seasonal components of time series. This program is among the most widely used in applied economic analyses. We also follow the suggested steps to evaluate and interpret the outcomes of testing procedures[2].

[1] All series are readily downloadable, for instance, from the website http://uif.bancaditalia.it/UICFEWebroot .

[2] The suggested steps are outlined, e.g., in documents downloadable from the US Census Bureau website www.census.gov, where the mentioned note by Higgison is also provided, or from the SAS website, www.support.sas.com/documentation.

If the F_S test supports the null hypothesis of no stable seasonality, time series are considered not to be seasonal; generally, a consistent conclusion is also provided by the K test, which shows that median values are constant across months. If, on the other hand, the F_S test rejects the null of no seasonality, assuming stability, seasonality is present. In the latter case, two outcomes can happen as far as the F_M test is concerned. If F_M accepts the null of no moving seasonality, stable seasonality is present, and the conclusion of "*identifiable stable seasonality present*" is reached; the program can easily disentangle the seasonal component. On the contrary, a rejection of the absence by part of F_M means that the seasonal component is moving over years, and the process of disentangling seasonality is difficult because the presence of moving seasonality can cause distortion. Depending on the combination of different tests, the program leads to the conclusion of "*identifiable stable seasonality not present*" or "*identifiable stable seasonality probably not present*"; the appropriate conclusion (i.e., "identifiable seasonality not present" or "probably not present") depends on the degree of moving seasonality relative to stable seasonality and has to be based on different combinations of tests. Such "negative" conclusions are problematic if the ultimate goal is to disentangle seasonality.

Measures of goodness of the de-seasonal procedure can be computed; for instance, the M7 statistic, which varies over the interval [0,3], is widely used in applied economic research, and values lower than 1 indicate an accurate de-seasonal procedure. An additional measure is represented by the Q statistic, which has to be lower than 1 to judge the de-seasonal series as acceptable. Our main goal in this Note, however, is not to derive de-seasonal time series but just to evaluate the presence of seasonal components; thus, the presence of moving seasonality is a result that is important per se, even if it prevents disentangling the seasonal component in a correct and efficient way, and even if the diagnostic statistics of the de-seasonal procedure lead to judging the de-seasonal series as unsuitable. Here, we prefer to conclude that the series is "not-seasonal" (rather than, "identified stable seasonality is not present") in the case in which both (i) the F-test on stable seasonality F_S does not reject the absence of seasonality at the 0.1% significance level and (ii) the K test does not reject the absence of seasonality at the 1% significance level. (The consideration of such threshold levels of confidence is recommended by US Census Bureau office and is generally taken into account by current applied research.) Results are presented in Table 1.

Table 1. Tests on seasonality

	(1) *F* on stable seasonality	(2) *K*	(3) *F* on moving seasonality	(4) M7-statistics Q-statistics	(5) Conclusion			
					A	B	C	D
(a1) DEM/USD 1974m01-1989m12	$F_{11,180}$=7.001**	K_{11}=67.720 (p=.0000)#	$F_{15,165}$=2.105	M7=0.97 Q=0.73	A			
(a2) DEM/USD 1990m01-2001m12	$F_{11,132}$=4.661**	K_{11}=41.50 (p=.0000)#	$F_{11,121}$=2.237	M7=1.21 Q=0.85			C	
(b) LIT/USD 1974m01-2001m12	$F_{11,324}$=4.842**	K_{11}=57.155 (p=.0000)#	$F_{27,297}$=2.297§	M7=1.20 Q=0.90			C	
(c) LIT/DEM 1974m01-2001m12	$F_{11,324}$=7.454**	K_{11}=95.319 (p=.0000)#	$F_{27,297}$=9.002§	M7=1.51 Q=0.92			C	
(d1) GBP/USD 1974m01-1990m12	$F_{11,192}$=2.087	K_{11}=26.897 (p=.0047)#	$F_{16,176}$=2.577§	M7=2.09 Q=1.15			C	
(d2) GBP/USD 1991m01-2010m12	$F_{11,228}$=2.584	K_{11}=22.881 (p=.0183)	$F_{19,209}$=5.888§	M7=2.19 Q=1.33				D
(e1) JPY/USD 1974m01-1990m12	$F_{11,192}$=1.794	K_{11}=20.655 (p=.0373)	$F_{16,176}$=2.886§	M7=2.09 Q=1.02				D
(e2) JPY/USD 1991m01-2010m12	$F_{11,228}$=1.128	K_{11}=14.138 (p=.2250)	$F_{19,209}$=3.523§	M7=2.79 Q=1.34				D
(f) EUR/GBP 1999m01-2010m12	$F_{11,132}$=2.523*	K_{11}=27.324# (p=.0041)	$F_{11,121}$=6.364§	M7=2.27 Q=1.13			C	
(g) EUR/JPY 1999m01-2010m12	$F_{11,132}$=2.934*	K_{11}=31.291# (p=.0010)	$F_{11,121}$=5.706§	M7=2.03 Q=1.31			C	
(h) EUR/USD 1999m01-2010m12	$F_{11,132}$=0.979	K_{11}=10.651 (p=.4730)	$F_{11,121}$=1.965	M7=2.56 Q=1.29				D

Note: Column (0): reports bilateral exchange rate; DEM stays for Deutsche Mark, USD for US dollar, LIT for Italian Lira, JPY for Japanese Yen, GBP for UK pound, EUR for Euro.
Column (1): * / ** means evidence of stable seasonality at the 1% / 0.1% level respectively;
Column (2): # means evidence of seasonality at the 1% level;
Column (3): § means evidence of moving seasonality at the 1% level;
Column (4): A= Identifiable stable seasonality present
B= Identifiable stable seasonality probably not present (according to the X-12 Arima procedure definition)
C= Identifiable stable seasonality not present (according to the X-12 Arima procedure)
D= Not seasonal (both the F test at the 0.1% significance and K test at the 1% significance lead to accept the absence of seasonality assuming stability)

In the case of the exchange rate between the German mark (DEM) and US dollar (USD), if we split the sample into two sub-periods (before and after January 1990), stable seasonality is present and detectable (thanks to its stability) in the first sub-period (January 1974 to December 1989), whereas it is present but not detectable because of the instability over the second period (lines a).

In the cases of the Italian lira (LIT) vs. USD and DEM, respectively, the evidence is substantially the same in different sub-periods (for this reason, the evidence concerning the different sub-periods is not provided by Table 1): monthly seasonality is present, but its instability does not permit it to be disentangled. (If we performed the test over the whole period, the conclusion would have been B, "Identifiable stable seasonality probably not present").

In the case of the exchange rate of the British pound (GBP) vs. USD, both the *F*-test and the *K*-statistic lead to acceptance of the absence of seasonality only for the sub-period 1991-2010, whereas in the previous considered period (1974-1990) the *K*-statistic is unable to support the absence of seasonality (however, the instability prevents its identification).

The inability of the tests to support the absence of seasonality, combined with significant instability of the seasonal component, applies also to the cases of the Euro (EUR) vs. GBP and Japanese yen (JPY), respectively.

Finally, EUR/USD (1999-2010) and JPY/USD (over both periods, 1974-90 and 1991-2010) are cases in which both the F test and K statistic indicate that the data are not seasonal.

In general, only in a few cases do all tests indicate that no seasonality is present (considering the recommended levels of confidence). These cases generally pertain to recent periods, apart from the case of JPY vs. USD over the 1974-1990 time span. In seven cases, signs of seasonality are present, although in six out of these seven cases, seasonality is not detectable because of its instability. In one case, identifiable stable seasonality emerged: the DEM-USD exchange rate over the Seventies and Eighties.

In our view, these pieces of evidence do not permit us to conclude that monthly seasonality is not a problem for exchange rates, as is assumed generally in the available literature. However, and admittedly, it is true that the problem of seasonality appears to diminish as more recent time periods are taken into consideration.

3. Concluding comments

As concerns the seasonality of monthly time series of bilateral nominal exchange rates, a variety of different results emerge in different cases from the real-world evidence. Nevertheless, in our view, the evidence lends itself to a clear interpretation. Generally speaking, seasonality is present during less recent periods. In more recent periods, the evidence of seasonality is absent according to widely accepted criteria.

We are ready to explain this evidence connecting the "disappearance of seasonality" with the growing financial integration. From this perspective, the following current interpretation can be accepted: determinants of exchange rates are seasonal; however, when possible, agents smooth the seasonal fluctuations of exchange rates. This is easier in a more financially integrated world.

References

Grilli, V., Roubini, N. (1992), Liquidity and exchange rates, *Journal of International Economics*, **32**, 339-52.

Higgison, J. (1975) "An F test for the presence of moving seasonality", mimeo; downloadable from the US Census Bureau website, www.census.gov

Jiménez-Martin, J.A., and Flores de Frutos, R. (2009), Seasonal fluctuations and equilibrium models of exchange rate, *Applied Economics*, **41**, 2635-52.

Meese, R., Rogoff, K. (1988), What is real? The exchange rate – interest differential relation over the modern floating rate period, *The Journal of Finance*, **43**, 933-48.

Miron, J.A. (1986), Seasonal fluctuations and the life cycle – permanent income model of consumption, *Journal of Political Economy*, **94**, 1258-79.