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Interactions between business cycles, stock market cycles and interest rates: the stylised facts*

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Résumé :

Nous proposons d'étudier les co-mouvements entre indices boursiers et activité réelle au cours du cycle économique en France, en Allemagne, en Italie, au Royaume-Uni et aux Etats-Unis au moyen de deux approches complémentaires. En premier lieu, nous identifions les points de retournement des indicateurs d'activité réelle et des indices boursiers et déterminons dans quelle mesure ces séries concordent. En second lieu, nous proposons de calculer les corrélations entre les composantes cycliques des indicateurs d'activité réelle et des excès de rentabilité, d'un côté et les corrélations entre les composantes permanentes des mêmes indicateurs, de l'autre.

Mots-clés : rendements des actions, co-mouvements, points de retournement, analyse spectrale.

Abstract:

In this paper, we study the co-movements between stock market indices and real economic activity over the business cycle in France, Germany, Italy, the United Kingdom and the United States, using two complementary approaches in our analysis. First, we identify the turning points in real economy indicators and stock market indices and determine the extent to which these series co-move. Second, we calculate the correlations between the cyclical components of real economy indicators and excess returns, on the one hand, and the correlations between the structural components and these indicators, on the other. We then analyse the co-movements between three-month interest rates and the cyclical and structural components of the real economy and stock market indices.

Keywords: stock returns, comovements, turning points, spectral analysis.

JEL Classification: E32, E44.

Résumé non technique :

Nous proposons d'étudier les co-mouvements entre indices boursiers et activité réelle au cours du cycle économique en France, en Allemagne, en Italie, au Royaume-Uni et aux Etats-Unis. Partant du principe qu'il n'existe ni une unique définition du cycle économique, ni une unique méthode pour l'étudier, nous analysons ce phénomène au moyen de deux approches complémentaires.

En premier lieu, nous identifions les points de retournement des indicateurs d'activité réelle et des indices boursiers et déterminons dans quelle mesure ces séries concordent, c'est-à-dire se retrouvent regulièrement et de façon significative dans la même phase du cycle. En second lieu, nous proposons de décomposer les séries étudiées en une partie dite cyclique et une partie dite permanente afin de calculer les corrélations entre les composantes cycliques des indicateurs d'activité réelle et des excès de rentabilité, d'un côté et les corrélations entre les composantes permanentes des mêmes indicateurs, de l'autre. Cette deuxième partie est complétée par une analyse des co-mouvements entre les taux d'intérêt à trois mois et les composantes cycliques et permanentes de l'activité et de la bourse.

Deux conclusions principales émergent de nos différentes analyses: (i) il ne semble pas exister un fort lien de dépendance entre les marchés boursiers et le niveau d'activité à court terme, sauf aux Etats-Unis ; (ii) à plus long terme, l'activité réelle et les marchés boursiers semblent partager les mêmes déterminants. En revanche, il paraît difficile d'identifier de façon claire un impact des prix d'actifs sur la conduite de la politique monétaire, identifiée ici par les taux à trois mois du marché monétaire. En général, on ne détecte pas de relation significative entre les parties cycliques des excès de rentabilité et des taux monétaires; on n'oberve pas non plus de lien significatif entre les composantes permanentes de ces mêmes variables.

Non-technical summary:

In this paper, we study the co-movements between stock market indices and real economic activity over the business cycle in France, Germany, Italy, the United Kingdom and the United States. Working on the premise that there is neither a single definition of the business cycle, nor a single method for studying it, we use two complementary approaches in our analysis.

First, we identify the turning points in real economy indicators and stock market indices and determine the extent to which these series co-move, i.e. are regularly and significantly in the same phase of the cycle. Second, we decompose the series studied into a cyclical part and a structural part in order to calculate the correlations between the cyclical components of real economy indicators and excess returns, on the one hand, and the correlations between the structural components and these indicators, on the other. We then analyse the co-movements between three-month interest rates and the cyclical and structural components of the real economy and stock market indices.

Two main conclusions can be drawn from our different analyses: (i) there does not appear to be a strong dependence between stock prices and the level of real activity in the short term, except in the United States; (ii) in the longer term, real activity and stock prices seem to share the same determinants. However, it seems difficult to accurately determine the impact of asset price movements on the conduct of monetary policy, represented here by three-month money market interest rates. In general, we do not detect a significant relationship between the cyclical components of excess returns and those of money market rates; nor do we find a significant link between the structural components of these variables.

1 Introduction

The spectacular rise in asset prices up to 2000 in most developed countries has attracted much attention and has re-opened the debate over whether these prices should be targeted in monetary policy strategies. Some observers see asset price developments, in particular those of stock prices, as being inconsistent with those of economic fundamentals, i.e. a speculative bubble. This interpretation carries with it a range of serious consequences arising from the bursting of this bubble: scarcity of financing opportunities, a general decline in investment, a fall in output, and finally a protracted contraction in real activity. Other observers believe that stock prices are likely to impact on goods and services prices and thus affect economic activity and inflation.

These theories are currently at the centre of the debate on whether asset prices should be taken into account in the conduct of monetary policy, i.e. as a target, or as an instrument.[1] However, the empirical link between asset prices and economic activity on the one hand, and the relationship between economic activity and interest rates or between stock prices and interest rates, on the other, are not established facts. This study therefore sets out to identify a number of stylised facts that characterise this link, using a statistical analysis of these data (economic activity indicators, stock prices and interest rates).

More specifically, we study the co-movements between stock market indices, real activity and interest rates over the business cycle. Assuming that there is not a single definition of the business cycle, we adopt an agnostic approach in our methodology.

The traditional approach characterises the cycle as a series of phases of expansion and contraction. Formally, expansion phases are defined as the periods of time separating a trough from a peak; conversely, contraction phases correspond to periods separating a peak from a trough. In this respect, it is vital to define and accurately identify peaks and troughs.

Although this view of the cycle fell out of fashion after the 1970s, it has recently come back into focus thanks to a number of studies, in particular by Harding and Pagan (2002a,b)[2] who

[1] Much theoretical literature has recently been published on this subject. See Bernanke and Gertler (2001), Bullard and Schalling (2002), Filardo (2000), and the refenrences cited in these papers

[2] For a recent application on euro data, see Artis et al. (2003)

proposed a simple method for analysing the concordance between macroeconomic variables. By definition, the concordance index represents the average number (standardised) of periods in which two variables (e.g. GDP and a stock market index) coincide at the same phase of the cycle.

The traditional approach defines the business cycle directly by analysing changes in the level of a variable, e.g. GDP. The modern approach, as we mentioned above, enables us to split a variable into two components, one cyclical or short-term, and the other permanent or structural, using the appropriate statistical techniques (filtering). As its name suggests, the cyclical component can be associated with the business cycle. Note that it is not possible to detect a trend in the latter. Consequently, we can calculate the correlations between the cyclical components of the two variables in order to study their co-movement (i.e. the similarity of their profile). However, we show that the structural component of a trend variable is also driven by a trend. Therefore, so as not to obtain false relationships, we study the growth rate of the structural components. We can also calculate the correlations between the growth rate of the structural components of the two variables in order to study their co-movement.

As the notions of concordance and correlation do not have an identical scope, it is useful to use both of these tools when attempting to characterise the stylised facts relating to the business cycle.

The first part of this study is devoted to the empirical analysis of the concordance indicator; the second part firstly describes changes in the variables studied (real activity, stock prices and interest rates) by separating the cyclical (or short term) components from the structural (or long term) components, and then compares the variables using the dynamic correlations of their corresponding components (i.e. cyclical/cyclical and structural/structural).

In both parts, we compare the results obtained on the business and stock market cycles of the monetary policies applied over the period studied: first, we analyse the behaviour of short-term interest rates over the phases of expansion and contraction of real activity and stock prices; second, we calculate the correlations between the cyclical components of real activity, stock prices and interest rates on the one hand, and the correlations between the structural components of these variables, on the other.

2 Concordance between business cycles and stock market cycles: an empirical analysis

As a concordance indicator, we use a descriptive statistic recently developed by Harding and Pagan (2002a,b) and utilised at the IMF by Cashin et al. (1999) and McDermott and Scott (2000). Cashin et al. applied this method to the analysis of the concordance of goods prices while McDermott and Scott used it to study the concordance of business cycles in major OECD countries.

The underlying method is based on studies by the National Bureau of Economic Research (NBER) and consists in dating the turning points in cycles. On the basis of these points, we can associate a contraction period with the lapse of time that separates a high point (peak) from a low point (trough). We follow the procedure advocated by Harding and Pagan (2002a,b) to identify turning points. This procedure states that a peak/trough has been reached at t when the value of the studied series at date t is superior/inferior to previous k values and to the following k values, where k is a natural integer that varies according to the type of series studied and its sampling frequency. A procedure is then implemented to ensure that peaks and troughs alternate, by selecting the highest/lowest consecutive peaks/troughs. Additional censoring rules are implemented, which, for example, restrict the minimal phase and cycle durations.[3]

We can then define the contraction and expansion phases for one or more variables and thus define the concordance statistic that indicates the average number (standardised) of periods in which two variables (e.g. GDP and a stock market index) coincide at the same phase of the cycle. There is a perfect concordance between the series (perfect juxtaposition of expansions and contractions) if the index is equal to 1 and perfect disconcordance (a marked lag or out of phase) if the index is equal to 0. The next section briefly reviews the concordance index.

[3] See appendix A for further details on the determination of business cycle dates.

2.1 The Concordance Index

Once the turning points of a variable y have been identified, we can define the binary variable $s_{y,t}$ such that

$$s_{y,t} = \begin{cases} 1 & \text{if } y \text{ is in expansion at } t \\ 0 & \text{otherwise} \end{cases}.$$

We proceed in the same fashion with x, by defining $s_{x,t}$. The concordance index between x and y, c_{xy}, is then defined as the average number of periods where x and y are identified simultaneously in the same phase, and is expressed as follows:

$$c_{xy} = \frac{1}{T}\sum_{t=1}^{T}\left[s_{x,t}s_{y,t} + (1 - s_{x,t})(1 - s_{y,t})\right],$$

Thus, c_{xy} is equal to 1 if x and y are always in the same phase and to 0 if x and y are always in opposite phases.

As McDermott and Scott (2000) observed, it is only possible to compute analytically the statistical properties of c_{xy} in a handful of particular cases. For example, if the processes x and y are independently drawn from the same Brownian motion, assuming that no censoring rules have been enforced in defining the turning points, then c_{xy} has mean 1/2 and variance $1/\left[4(T-1)\right]$. Notice that if T is very large, the variance of c_{xy} converges to 0 (c_{xy} is asymptotically constant).

However, in general, the distribution properties of c_{xy} are unknown, especially when the censoring rules have been enforced. In order to calculate the degrees of significance of these indices, we use the method suggested by Harding and Pagan (2002b) given below. Let μ_{s_i} and σ_{s_i}, $i = x, y$ denote the empirical average and the empirical standard deviation of $s_{i,t}$, respectively. If ρ_s denotes the empirical correlation between $s_{x,t}$ and $s_{y,t}$, we demonstrate that the concordance index can be expressed as follows:

$$c_{xy} = 1 + 2\rho_s\sigma_{s_x}\sigma_{s_y} + 2\mu_{s_x}\mu_{s_y} - \mu_{s_x} - \mu_{s_y}, \tag{2.1}$$

According the equation (2.1), c_{xy} and ρ_s are linked in such a way that either of these two statistics can be studied to the same effect. In order to calculate ρ_s, Harding and Pagan estimate the linear relationship:

$$\left(\frac{s_{y,t}}{\sigma_{s_y}}\right) = \eta + \rho_s \left(\frac{s_{x,t}}{\sigma_{s_x}}\right) + u_t, \tag{2.2}$$

where η is a constant and u_t a residual.

The estimation procedure of equation (2.2) must be robust to possible serial correlation in the residuals, as u_t inherits the serial correlation properties of $s_{y,t}$ under the null hypothesis $\rho_s = 0$. The ordinary least squares method augmented by the HAC procedure is therefore used here for estimating equation (2.2).

Notice that (2.1) makes it clear that it is difficult to a priori assess the significance of c_{xy} relative to 0.5. Indeed, in the case of independent, driftless, Brownian motions, $\rho_s = 0$, and $\mu_{s_x} = \mu_{s_y} = 1/2$, so that $c_{xy} = 1/2$. Now, assume that x and y are drawn from the same Brownian motion, though characterized by drifts, so that $\mu_{s_x} = \mu_{s_y} = 0,9$. In this case, using (2.1), one demonstrates that $c_{xy} = 0,82$. However, x and y have been sampled independently, and should not be characterized by a high degree of concordance. Thus, a high value for c_{xy} relative to 1/2 is not synonymous with a high degree of concordance.

2.2 Presentation of data

We set out to study the relationship between business cycles and stock market cycles in Germany, the United Kingdom, the United States, France and Italy.[4] Stock prices are obtained from composite indices calculated by Morgan Stanley (MSCI), deflated by the consumer price index. These variables are available at a quarterly and a monthly frequency. We use three variables to define the business cycle: at a quarterly frequency, market GDP and household consumption (these variables are taken from the OECD database over the study period from Q2 1978 to Q3 2002); and at a monthly frequency, retail sales (in volume terms, over the period 1978(1)-2002(12)). This series is only available as of 1990 for Italy. We therefore do not take this country into account in our analysis of monthly data. Moreover, the monthly sales index displays a highly erratic behaviour pattern that could conceal some turning points. In

[4] For a presentation of the data, see box 1.

Box 1 empirical data

The data used in this study are explained below:

- *Financial data*: Morgan Stanley Capital International (MSCI) indices obtained from Datastream. In order to calculate excess returns, we use the nominal interest rate on government bonds (annualised) for the United States, France and the United Kingdom, the interbank rate for Germany and the money market rate for Italy. For all of these countries, we use the three-month money market rates as indicators of monetary policy. These data are obtained from the IMF database.

- *Real data*: real market GDP and real private consumption are expressed in volume terms at 1995 prices. Real sales are obtained from the real retail sales index (1995 base). These data are obtained from the OECD database. We also use the consumer price index from the same database to deflate the stock market indices.

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order to avoid this, we prefilter these data[5] in order to strip out the most erratic parts of these series and focus the analysis on an adjusted version of these variables.

2.3 Results

The turning points in real GDP, real consumption and MSCI indices are shown in Charts 1, 2, and 3, respectively. Those of the retail sales index and MSCI indices at a monthly frequency are given in Charts 4 and 5, respectively.

At a quarterly frequency, results derived from the charts relating to real activity variables (Charts 1 and 2) are compatible overall and consistent with the analysis of McDermott and

[5] See Watson (1994).

Scott (2000) and with that of Artis et al (2003). Naturally, we do not detect a perfect identity between the cycles described by GDP and real consumption. In France, for example, a short contraction can be observed in 1995 when we study private consumption data, whereas the French economy was in a phase of expansion according to GDP data. When studying the turning points observed in stock markets, we note in particular that they are more frequent than in the real economy, irrespective of the country considered in our sample. The long phase of expansion in the 1990s is clearly visible in all countries. Some pronounced lags are observed between the phases of the business and stock market cycles, in particular in Europe, especially at the start of the 2000s.

We note that the retail sales index is a more or less reliable indicator of private consumption and is more volatile than the latter. Nevertheless, these are the two indicators that must be compared. We therefore compare the turning points derived from the analysis of these two variables. Overall, in sales indices we observe the same marked contractions as those in consumption, as well as more occasional contractions, consistent with the high volatility of sales indices. We can carry out the same analysis on stock market indices at two frequencies: all pronounced contractions at a quarterly frequency can also be observed at a monthly frequency; here too, more contractions are detected at a monthly frequency.

These initial findings obtained from analysing the charts naturally call for a more in-depth study of the co-movements of real economy and stock market variables.

Table 1 lists the intra-country index of concordance between MSCI indices and the three real activity indicators used.

The United States appears to be characterised by a significant concordance between the level of real activity and stock prices. Indeed, this is the case for the three real activity indicators used, which is not surprising in view of the role of stock markets in the investment and financing behaviour of US economic agents. The same is not true of the other countries in the sample. In particular, we do not observe this concordance of cycles in EU countries.

Business and stock market cycles do not occur at the same frequencies and furthermore may be uncorrelated, with the exception of the United States. Indeed, an analysis of Charts 1 (or 2) and 3 shows that the duration of a stock market expansion is generally shorter than that of GDP or consumption. This difference naturally contributes to reducing the degree of concordance between real activity and stock markets.

Nevertheless, the lack of significant concordance in most countries under review does not necessarily mean that business and stock market cycles are different or uncorrelated phenomena. The result obtained simply highlights the fact that the periods of expansion and contraction of GDP and stock prices for example do not coincide.

We observe that the start of US stock market contractions (i.e. the dates of peaks) precede contractions in real activity measured by real GDP.[6] The lag oscillates between one and four quarters. We also note that not all stock market contractions result in contractions in real activity. In particular, when they are very short like in 1987, they do not seem to spill over into activity. A similar phenomenon can be detected in European countries such as France and Italy. Like in the United States, but to a lesser degree, the start of GDP contractions are preceded by stock market contractions. Likewise, most stock market contractions in these two countries did not lead to contractions in real activity.

Lastly, this rule does not apply to Germany and the United Kingdom. Stock market contractions may precede or follow contractions in real activity by more than a year.

Therefore, contrary to received wisdom, it does not always appear relevant to use negative turning points in stock markets as leading indicators of the start of a contraction phase of GDP or consumption.

Turning now to the relationship between monetary policy and business and stock market cycles, we observe a relative decoupling between certain contraction periods of real activity or stock markets and money market rate developments, used here as indicators of monetary policy (Chart 6). No clear rule emerges from a comparison between stock markets and money markets: for the business cycle, a decline in rates more or less coincides with a contraction but, here too, it is difficult to establish a general rule. This chart suggests that the reaction of money market rates to turnarounds in real activity or stock markets was not systematic or correlated in the countries studied. This corresponds in theory to the mandate of monetary authorities as well as to the way in which we have modelled monetary policy rules in recent

[6] To date, statistics for testing the significance of these lags do not exist

macroeconomic studies.[7]

Concordance indices have enabled us to measure the degree of "juxtaposition" between two chronological series, without having to consider whether there is a trend in the variables (non-stationarity). It should nevertheless be noted that only one aspect of the notion of cycles is taken into account here.

It could therefore be useful to broaden the study by retaining the concepts of phase and duration, but without limiting ourselves to such restrictive indicators as concordance indices. To do this, we decompose, in Part two, the different series studied in order to isolate the long-term (or structural) components and the short-term (or cyclical) components; the latter correspond to the business cycle concept put forward by the NBER.

3 Correlations of cyclical and structural components

On the basis of NBER studies, we identify business cycles with all movements whose recurrence period is between 6 and 32 quarters. This corresponds to the frequency of business cycles. Furthering this approach, macroeconomic literature recently defined the movements of a variable (a_t) in terms of the time frequencies of its components. That corresponding to the business cycle is determined as the residual obtained after stripping out long movements, imputable to structural economic factors (τ_t).[8] By construction, the residual variables ($a_t - \tau_t$) obtained by robust statistical techniques (filtering) are detrended (stationary). We can thus calculate the correlations between the corresponding components of the series in the hope of isolating a set of statistical regularities or stylised facts that characterise the business cycle.

The analysis of these components is based on the assumption that it is possible to isolate them from each other. To this end, we use two complementary non-parametric methods. First, we resort to the band pass filter recently put forward by Christiano and Fitzgerald (2003) (CF). For each country and each variable (a_t), we thus define the short-term (or

[7] See, in particular, studies in the collective work edited by Taylor (1999).

[8] This is the approach generally adopted following Kydland and Prescott (1982).

cyclical, a_t^{ct}) components and the long-term (or structural, a_t^{lt}) components and calculate the correlations between the corresponding components. Second, we compute the dynamic correlations between the studied variables, following the work by Croux et al. (2001).

The following section briefly reviews the methodological tools used.

3.1 A Brief Review of Spectral Analysis

3.1.1 The Band Pass Filter

The ideal band pass filter used to isolate cyclical movements, whose recurrence periods are between the interval $[b_i, b_s]$, is defined by the following equation:

$$y_t^{\text{ct}} = B(L)\, y_t, \;\; B(L) = \sum_{k=-\infty}^{k=+\infty} B_k L^k, \;\; L^k y_t = y_{t-k},$$

where the B_k's are expressed as:

$$B_k = \frac{\sin(2k\pi/b_i) - \sin(2k\pi/b_s)}{\pi k}.$$

In order to interpret the role played by the filter, we introduce the concept of *spectral density*. The spectral density of the stationary stochastic process y_t, denoted $S_y(\omega)$, is interpreted as the decomposition of the variance of y_t in the domain of the frequencies. As y_t can be decomposed into a sum of orthogonal cyclical movements that each appear at a different frequency, we can interpret $S_y(\omega)$ as the variance of y_t explained by the cyclical movements operating at frequency ω.

A classic result of spectral analysis shows us that, under certain conditions, the equation $y_t^{\text{ct}} = B(L)\, y_t$ implies that the spectral density of the process y_t^{ct}, $S_{y^{\text{ct}}}(\omega)$, is deduced from that of y_t, $S_y(\omega)$, using the formula

$$S_{y^{\text{ct}}}(\omega) = \left\|B\left(\mathrm{e}^{-i\omega}\right)\right\|^2 S_y(\omega),$$

where $||B(\mathrm{e}^{-i\omega})||^2$ is the squared modulus of $B(\mathrm{e}^{-i\omega})$. Given the definition of B_k, a direct calculation shows that

$$B\left(\mathrm{e}^{-i\omega}\right)=\begin{cases}1 & \text{pour } \omega\in]2\pi/b_s,2\pi/b_s[\cup]-2\pi/b_i,-2\pi/b_s[\\ 0 & \text{sinon}\end{cases}.$$

From this formula it can be observed that the spectral density of y_t is not zero on the frequency band $]2\pi/b_s,2\pi/b_s[\cup]-2\pi/b_i,-2\pi/b_s[\subset]-\pi,\pi[$, and zero everywhere else. In other words, all the variance of y_t^{ct} is explained by cyclical movements whose recurrence periods are between b_i and b_s.

The definition of the filter $B(L)$ imposes a major limitation, as it requires a dataset of infinite length. In practice, we work with a finite sample and must therefore make an appropriate approximation of $B(L)$. Starting from a finite number of observations $\{y_1,\ldots,y_T\}$ of the stochastic process y_t, Christiano and Fitzgerald (2003) define the optimal linear approximation $\hat{y}_t^{\mathrm{ct}}$ of y_t^{ct} as the solution to the problem

$$\min \mathrm{E}\left[\left(y_t^{\mathrm{ct}}-\hat{y}_t^{\mathrm{ct}}\right)^2 \mid \{y_1,\ldots,y_T\}\right]. \tag{3.1}$$

The method therefore consists in minimising the mathematical expectation of the square error between the ideally filtered series and the approximately filtered series, where the expectation is conditioned on all the available data.

3.1.2 Dynamic Correlation

Consider a stochastic a bivariate stationary stochastic process $(x_t,y_t)'$. The classical notion of correlation is a static measure of the linear relation between x_t and y_t. To the contrary, the notion of dynamic correlation between x_t and y_t, denoted $\rho_{xy}(\omega)$, permits us to decompose the correlation between these series in the frequency domain.. In particular, it permits to quantify the amount of covariation between the cyclical components of x_t and y_t, at frequency ω.

Let us define more formally the notion of dynamic correlation. Let $S(\omega)$ denote the spectral density of $(x_t,y_t)'$

$$S(\omega)=\begin{pmatrix} S_x(\omega) & S_{xy}(\omega)\\ S_{yx}(\omega) & S_y(\omega)\end{pmatrix},\ \omega\in[-\pi,\pi],$$

where the cross-spectrum $S_{xy}(\omega)$ is a complex number such that $S_{xy}(\omega) = S_{yx}(\omega)'$. The dynamic correlation between $(x_t, y_t)'$ is defined by the relation

$$\rho_{xy}(\omega) = \frac{C_{xy}(\omega)}{\sqrt{S_x(\omega) S_y(\omega)}}, \ \omega \in [0, \pi[$$

where $C_{xy}(\omega)$ is the real part of $S_{xy}(\omega)$. Thus the dynamic correlation is the correlation coefficient between real waves of frequency ω appearing in the spectral decomposition of x_t and y_t.

To estimate $\rho_{xy}(\omega)$, we first estimate $S(\omega)$ through the autocovariances $z_t = (x_t, y_t)'$, which we smooth by means of a Bartlett window. To compute the confidence intervals reported below, we used a traditional block-bootstrap approach.

3.2 Empirical Results

The different real activity indicators are logarithms of real market GDP and private consumption; for the financial sphere, we consider the excess returns on stocks relative to the risk-free interest rate.[9] Here, the analysis is limited to quarterly frequencies.

We propose two applications. First, for each country, we calculate the correlation between the cyclical (short-term) components of the variables studied and the correlation between the structural (long-term) components. In the latter case, we do not deal with real activity indicators and measures of returns in the same way. Indeed, real activity indicators are characterised by trends and therefore do not have the required statistical properties (they are not stationary) for calculating the correlations.[10] We show that their long-term components are non-stationary too. Consequently, we focus on the growth rate of the structural components that are, in general, stationary (in particular, they are not characterised by a trend). Conversely, the excess returns on stocks relative to the risk-free interest rate and their components are stationary. We can therefore study these variables in level form. For further details, see Box 2.

[9] Excess returns are defined as the difference between the nominal interest returns on stocks and on three-month government bonds.

[10] The notion of correlation is only defined for stationary variables. Where non-stationarity is present, the analysis of correlations yields spurious results.

Second, for each country, we calculate the dynamic correlation between excess returns and either GDP growth or consumption growth. We settle to study growth rates of trending variables for the same reasons as those outlined above. Thus, it is important to keep in mind that the dynamic correlation between output growth and excess returns at low frequencies does not exactly cover the same phenomenon as the simple correlation between the structural component of excess returns and the growth rate of the structural component of output.

From Tables 2 and 3, we cannot conclude that there is a strong link between the cyclical components of GDP or consumption and those of excess returns in the different countries reviewed.

However, in the United States, France and Germany, the correlation between y^{ct}_{t+k} and x^{ct}_{t} is significantly positive for $k = 2$ or 3 quarters. This means that a positive variation of the cyclical component of GDP at $t + 2$ or at $t + 3$ is associated with a positive variation of the cyclical component of excess returns at t. In other words, a positive variation of the cyclical component of GDP follows an increase in the cyclical component of excess returns with a lag of two or three quarters.[11] Even though the share of equities in household wealth differs on both sides of the Atlantic[12] the reactions of the three economies displays a certain convergence. A similar link is observed for the cyclical component of consumption, although the lag in the correlation appears to be closer to three quarters.

However, the correlations between the growth rate of the structural component of GDP and the structural component of excess returns are significantly positive for all countries, at a fairly short horizon (Tables 4 and 5). The structural determinants of excess returns appears to covary positively with those of real activity. This result is borne out overall when consumption is used as a real activity indicator, at least for short horizons.[13]

The previous results are partly confirmed by the dynamic correlation analysis. Figure 7 reports the dynamic correlation between GDP growth and excess returns. This graph clearly

[11]This result must however be considered with caution as the sign of the correlation coefficient sometimes changes with k in some countries (see the line corresponding to the United States).

[12]See Odonat and Rieu (2003).

[13]We can compare these conclusions with those of Daniel and Marshall (1998). These authors show that it is not possible to reject the augmented C-CAPM models when consumption and excess returns have been stripped of their short-term cyclical movements.

Box 2 determining the components

In order to determine the cyclical components, we adopt the traditional definition of the cycle presented above. For all the variables studied, the business cycle is identified with all movements whose recurrence period is between 6 and 32 quarters. In order to isolate the structural components, we apply the CF filter so as to strip out the cyclical movements with a recurrence period of less than 32 quarters. We then calculate the difference between the initial series and the filtered series in order to obtain the structural component.

Let y_t denote the log of real GDP at t and x_t the excess return at t. For each country i ($i = FRA, USA, GBR, GER, andITA$), we calculate the following correlations:

- the correlation between the cyclical component of GDP and excess returns, $y^{ct}_{t+k}(i)$ and $x^{ct}_t(i)$, for $k = -3, ..., 3$;
- the correlation between the growth rate of the structural component of GDP, $\Delta y^{lt}_{t+k}(i)$, and the structural component of excess returns $x^{lt}_t(i)$, for $k = -3, ..., 3$;

where Δ is the first difference operator ($\Delta a_t = a_t - a_{t-1}$). We establish k as ranging from -3 to 3 as is the usual practice in studies of US data. For the purposes of symmetry, we adopt the same horizon for the other countries. As mentioned above, the exponent ct denotes the short-term component and the exponent lt denotes the long-term component. We estimate these correlations using a robust econometric method: the Generalised Method of Moments (GMM) completed with the HAC procedure developed by Andrews and Monahan (1992). We use the same methods for real private consumption, replacing y_t by c_t, the logarithm of consumption.

shows that in most countries, this correlation is significantly positive at low frequencies while not always significantly different from zero at higher frequencies. This confirms our analysis: excess returns and real activity are strongly linked at low frequencies, because they share possibly common structural determinants; conversely, at shorter horizons, the determinants of these variables can differ. Figure 8 reports the dynamic correlation between consumption growth and excess returns. Once again, we obtain similar results, even though the dynamic correlation appears to be higher at higher frequencies for some countries.

If we compare the cyclical and structural components of the real activity indicator, stock prices and interest rates, we see that in most countries studied (Table 6), with the notable exception of France, the correlation between the cyclical component of GDP and that of the nominal interest rate is positive for negative k and negative for positive k. These results seem to point to a stabilising monetary policy: temporary rises in the level of real activity are followed by temporary increases in the money market rate, which precede a decline in the cyclical component of GDP. The difference in the French case may be due, *inter alia*, to the implementation of the "strong franc" policy at the start of the 1980, which introduced a break.

We do not, however, detect a significant relationship between the cyclical component of excess returns and that of money market rates (Table 7), except in the United Kingdom: overall, short-term fluctuations in excess returns appear in some respects to be independent of those in money market rates. If we use these rates to represent monetary policy, this analysis does not rule out the possibility that monetary authorities may have reacted to some stock market events, but it indicates that, in general, stock price fluctuations do not play a determining role in the conduct of their policy. In results not reported here, we obtain confirmation of this conclusion with the dynamic correlation approach. The latter is not found staistically significant at business cycle frequencies.

Table 8 suggests that there is a negative relationship between the long-term component of the money market rate and that of real GDP in the United States, France, Germany (where we observe a lag), and, to a lesser extent, Italy.[14] This relationship means that a

[14] Once again, we obtain similar results with the dynamic correlation approach.

lasting rise in the money market rate results in a fall in the growth rate of the long-term component of GDP. We could enhance the interpretation of this result by comparing the long-term components of real activity with those of real interest rates, calculated *ex-ante*, in keeping with economic theory. However, this exercise is not easy because no simple and reliable measurement of this interest rate is available.

Lastly, we do not detect a significant link between the long-term component of the money market rate and that of the excess returns (Table 9), except in the United Kingdom and to a lesser extent in the United States. The long-term component of interest rates therefore does not appear to react to the structural component of excess returns, expect in the United Kingdom and the United States, no doubt owing to the weight of equities in household wealth that characterises these countries.

4 Conclusion

In order to understand the link between business cycles and stock market cycles and use it to improve the conduct of monetary policy, it is first necessary to identify the stylised facts underlying this relationship.

In practice, we set out to study the links between business and stock market cycles by using two complementary approaches that enable us to measure the co-movements between these phenomena.

Firstly, in the tradition of the NBER, we defined the business cycle as a succession of phases of expansion and contraction in order to compare the cycles based on two variables by calculating their concordance index. Above all, this exercise allowed us to identify significant concordance between the business and stock market cycles in the United States.

Secondly, using the predominant methodology in applied macroeconomics, we analysed this link by decomposing the variables studied into short- and long-term components and by calculating the correlations between corresponding components (i.e. cyclical/cyclical and structural/structural).

We draw two conclusions from the various analyses carried out: *(i)* there does not seem to be a strong dependence link between stock prices and the level of real activity at business cycle frequencies, except in the United States; *(ii)* in the longer term, it appears that real activity and stock prices share the same determinants. At any rate, we cannot clearly identify an impact of asset prices on three-month interest rates, used to represent monetary policy in the countries studied. In general, we do not detect a significant relationship between the cyclical components of excess returns and money market rates, nor do we observe a significant link between the structural components of these same variables

These conclusions appear to be robust. However, it may be useful to further investigate the dichotomy between the short- and long-term using an approach based on a behavioural analysis of agents (or a microeconomic analysis of markets). In particular, we will attempt to identify the transmission mechanisms that enable us to detect links between business and stock market cycles.

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Table 1. Concordance between real and financial cycles

	USA	**FRA**	**GER**	**UKG**	**ITA**
PIB	0.68687 (∗)	0.61616	0.62626	0.58586	0.54545 (∗)
Cons.	0.64646 (∗)	0.60606	0.66667 (∗)	0.59596	0.53535
Sales	0.73874 (∗)	0.54655	0.56456	0.62462 (∗)	—

Notes : a star denotes a coefficient significant at the 5 % level. These levels are determined according to the method advocated by Harding et Pagan (2002b). See appendix B for further details.

Table 2. Short-run correlation GDP-stock prices

k	-3	-2	-1	0	1	2	3
USA	−0.0097	−0.1872	−0.2940	−0.2835	−0.1528 (∗)	0.0493	0.2461 (∗)
FRA	−0.0020	0.1015	0.2178	0.2884	0.2729 (∗)	0.1789 (∗)	0.0377
GER	−0.1131	−0.1129	−0.0438	0.0656	0.1666 (∗)	0.2357 (∗)	0.2625 (∗)
UKG	0.1215	0.1276	0.0875	0.0070	−0.0675	−0.1023	−0.0938
ITA	0.1279	0.1631	0.1647	0.1381	0.0997	0.0769	0.0731

Notes : Correlation between $y^{\mathrm{ct}}_{t+k}(i)$ and $x^{\mathrm{ct}}_t(i)$, where i is the country in the first column. A star denotes a coefficient significant at the 5 % level.

Table 3. Short-run correlation consumption-stock prices

k	-3	-2	-1	0	1	2	3
USA	−0.1076	−0.1958	−0.2181	−0.1530	−0.0165	0.1352	0.2368 (∗)
FRA	−0.2315	−0.0839	0.0949	0.2280	0.2929 (∗)	0.2659 (∗)	0.1707
GER	−0.1902	−0.2442	−0.2528	−0.2024	−0.0995	0.0502	0.2125 (∗)
UKG	0.0208	−0.0262	−0.0816	−0.0975	−0.0609	0.0012	0.0248
ITA	−0.0323	0.0018	0.0369	0.0793	0.1251	0.1830 (∗)	0.2362 (∗)

Notes : Correlation bteween $c^{\mathrm{ct}}_{t+k}(i)$ and $x^{\mathrm{ct}}_t(i)$.

Table 4. Long-run correlation GDP-stock prices

k	-3	-2	-1	0	1	2	3
USA	0.6243 (∗)	0.6528 (∗)	0.6665 (∗)	0.6653 (∗)	0.6415 (∗)	0.6073 (∗)	0.5641 (∗)
FRA	0.1872 (∗)	0.3062 (∗)	0.4179 (∗)	0.5197 (∗)	0.5997 (∗)	0.6650 (∗)	0.7143 (∗)
GER	0.0622	0.1381	0.2128	0.2845	0.3265 (∗)	0.3663 (∗)	0.4029 (∗)
UKG	0.6161 (∗)	0.6242 (∗)	0.6175 (∗)	0.5965 (∗)	0.5586 (∗)	0.5093 (∗)	0.4501 (∗)
ITA	0.4909 (∗)	0.5735 (∗)	0.6424 (∗)	0.6959 (∗)	0.7254	0.7423	0.7462

Notes : Correlation entre $\Delta y^{\mathrm{lt}}_{t+k}(i)$ and $x^{\mathrm{lt}}_t(i)$.

Table 5. Long-run correlation consumption-stock prices

k	-3	-2	-1	0	1	2	3
USA	0.3898	0.4041	0.4091 (∗)	0.4054 (∗)	0.4060	0.3989 (∗)	0.3850 (∗)
FRA	0.0629	0.1698 (∗)	0.2714 (∗)	0.3653 (∗)	0.4580 (∗)	0.5369 (∗)	0.6006 (∗)
GER	0.0974	0.1675	0.2362	0.3019	0.3425 (∗)	0.3804 (∗)	0.4149 (∗)
UKG	0.3423	0.3855	0.4175	0.4380	0.4556 (∗)	0.4602 (∗)	0.4522 (∗)
ITA	0.3377 (∗)	0.4391 (∗)	0.5305 (∗)	0.6098 (∗)	0.6598 (∗)	0.6991 (∗)	0.7266 (∗)

Notes : Correlation between $\Delta c^{\mathrm{lt}}_{t+k}(i)$ and $x^{\mathrm{lt}}_t(i)$.

Table 6. Short-run correlation GDP-money rates

k	-3	-2	-1	0	1	2	3
USA	0.5341 (∗)	0.6218 (∗)	0.6334 (∗)	0.5430 (∗)	0.3629 (∗)	0.1096	−0.1750 (∗)
FRA	0.1775	0.1996	0.1827	0.1188	0.0219	−0.0801	−0.1720
GER	0.7303 (∗)	0.7233 (∗)	0.6299 (∗)	0.4475 (∗)	0.2020 (∗)	−0.0585	−0.2846 (∗)
UKG	0.5535 (∗)	0.5172 (∗)	0.3870 (∗)	0.1663	−0.0904	−0.3187 (∗)	−0.4740 (∗)
ITA	0.5129 (∗)	0.5983 (∗)	0.5702 (∗)	0.4524 (∗)	0.2644	0.0973	−0.0137

Table 7. Short-run correlation stock prices-money rates

k	−3	−2	−1	0	1	2	3
USA	−0.0115	−0.1372	−0.2137 (*)	−0.2298	−0.1842	−0.1009	−0.0007
FRA	−0.1078	−0.1159	−0.0643	−0.0195	−0.0058	−0.0222	−0.0417
GER	0.0796	0.0778	0.0580	0.0235	−0.0111	−0.0231	−0.0071
UKG	−0.1632	−0.0729	0.1482	0.3792 (*)	0.4989 (*)	0.4289 (*)	0.2083 (*)
ITA	−0.0950	−0.0931	−0.0750	−0.0301	0.0367	0.1051	0.1381 (*)

Table 8. Long-run correlation GDP-money rates

k	−3	−2	−1	0	1	2	3
USA	−0.2332	−0.2493	−0.2600 (*)	−0.2646 (*)	−0.2761 (*)	−0.2776 (*)	−0.2685 (*)
FRA	−0.2404	−0.2906 (*)	−0.3363 (*)	−0.3764 (*)	−0.4187	−0.4549	−0.4835
GER	0.1101	0.0233	−0.0612	−0.1417	−0.2272	−0.3044 (*)	−0.3715 (*)
UKG	−0.3266	−0.3582	−0.3824	−0.3986	−0.4026	−0.3929	−0.3691
ITA	0.1183	0.0932 (*)	0.0732	0.0587	0.0309	0.0086	−0.0077

Table 9. Long-run correlation stock prices-money rates

k	−3	−2	−1	0	1	2	3
USA	0.0312	0.0615	0.0895	0.1155 (*)	0.0606	0.0112	−0.0316
FRA	−0.1670	−0.1386	−0.0995	−0.0497	−0.0618	−0.0630	−0.0528
GER	−0.2636	−0.2238	−0.1724	−0.1097	−0.1036	−0.0860	−0.0571
UKG	0.2013 (*)	0.2068 (*)	0.2163 (*)	0.2305 (*)	0.1796	0.1347	0.0971
ITA	0.0489	0.1047	0.1693	0.2421	0.2326	0.2276	0.2270

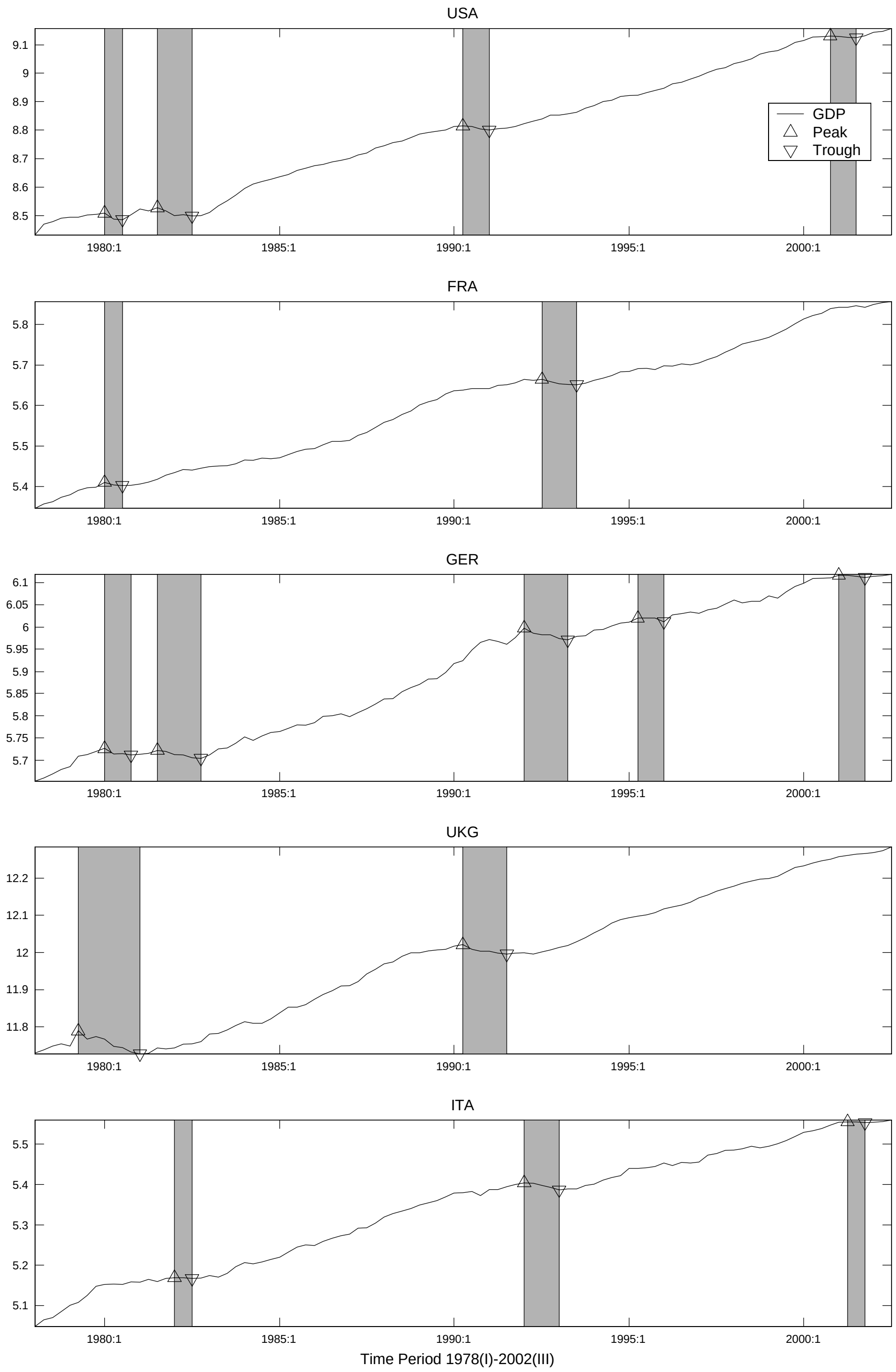

Figure 1: Turning points for real GDP, 1978(I)-2002(III).

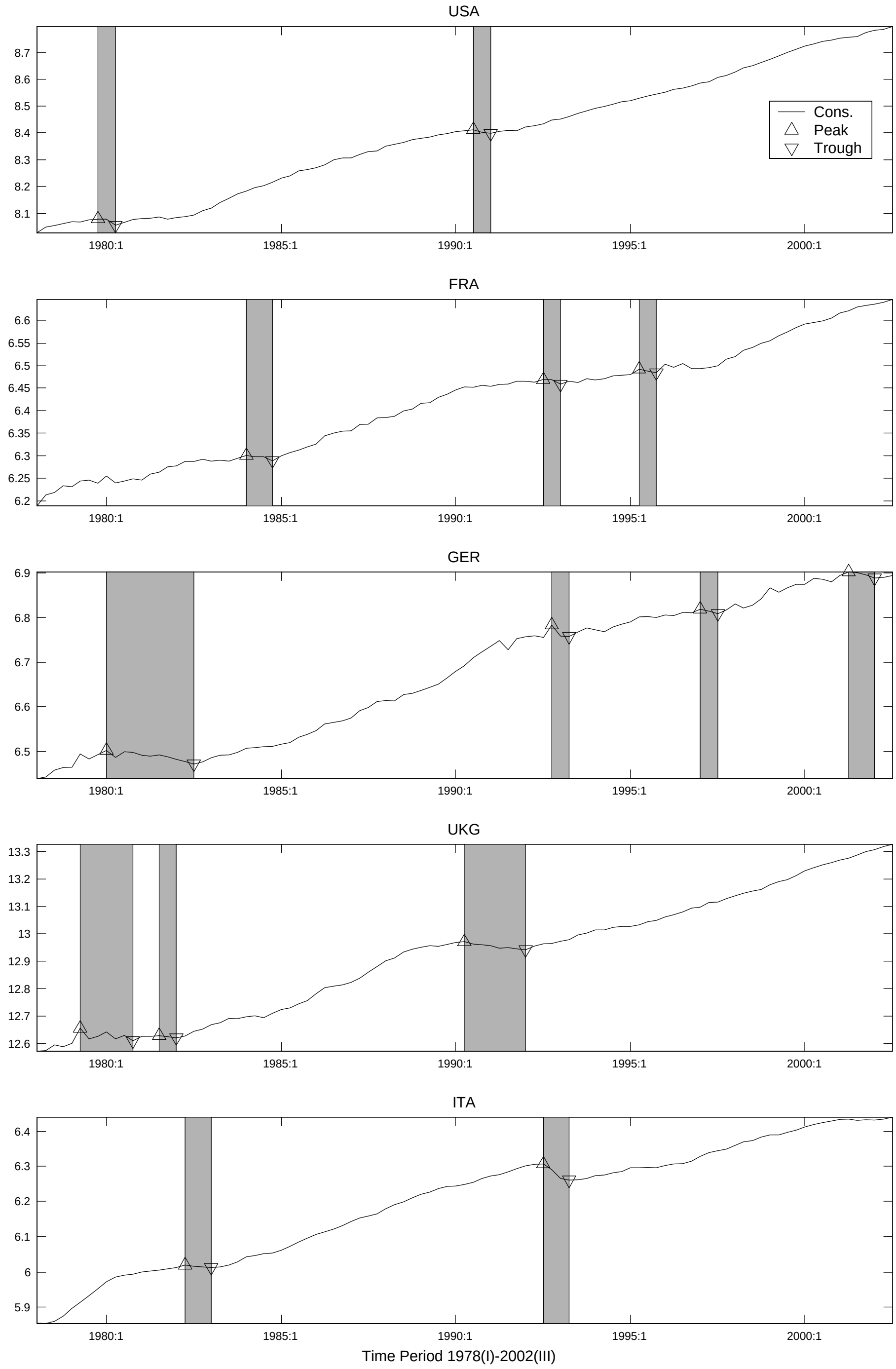

Figure 2: Turning points for real private consumption, 1978(I)-2002(III).

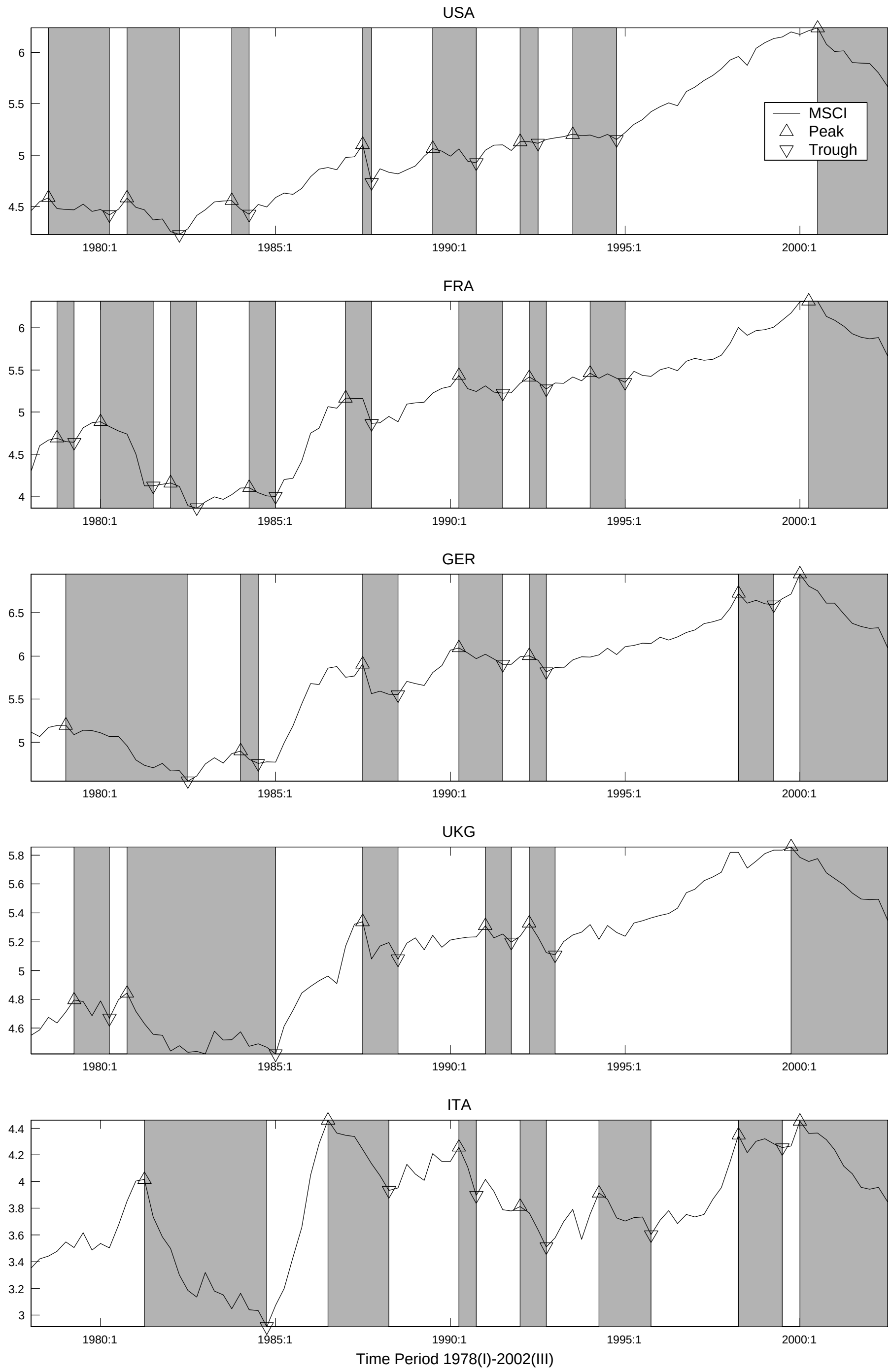

Figure 3: Turning points for MSCI return indeces, 1978(I)-2002(III).

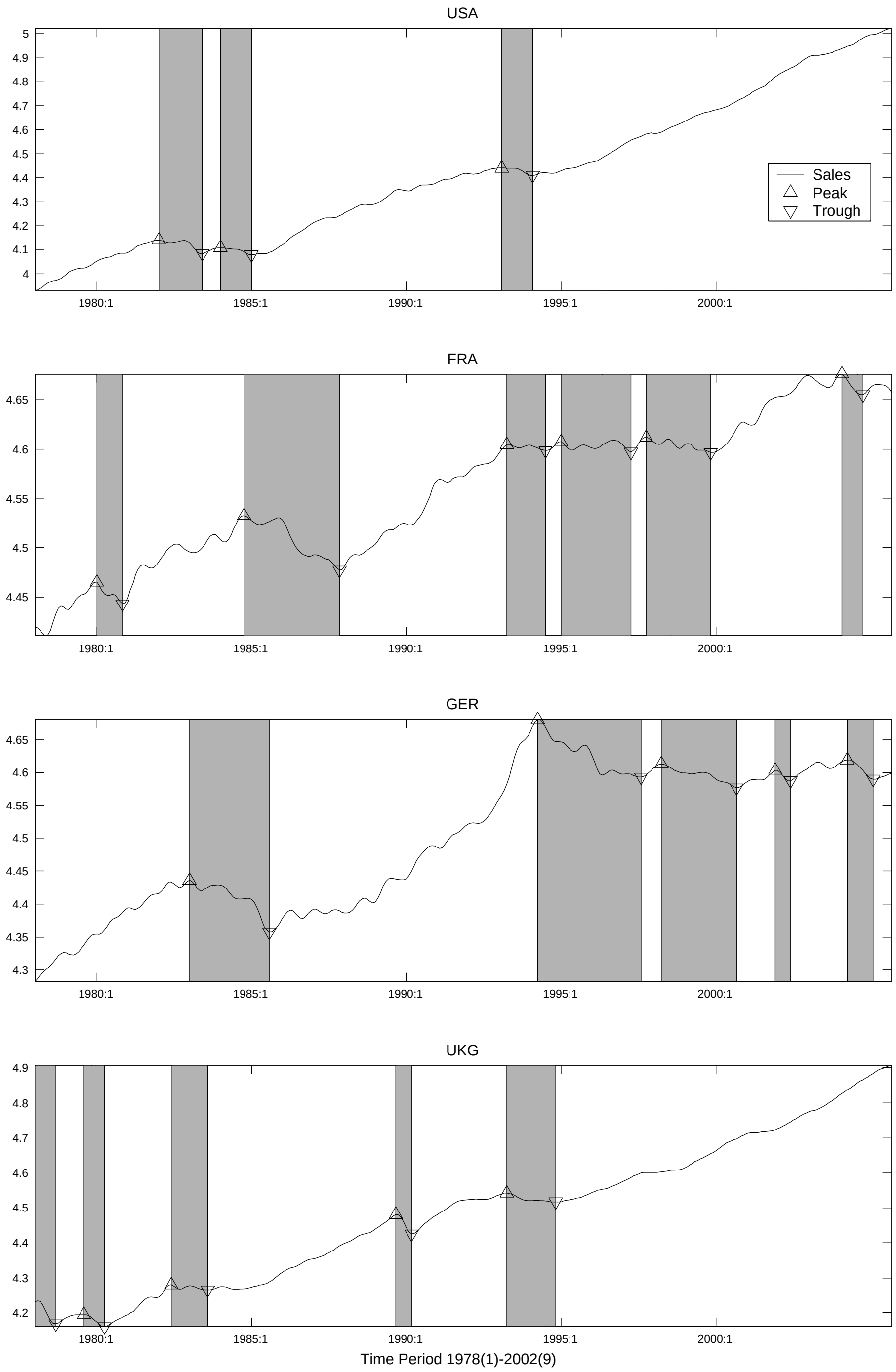

Figure 4: Turning points for retail sales index (filtered), 1978(1)-2002(9).

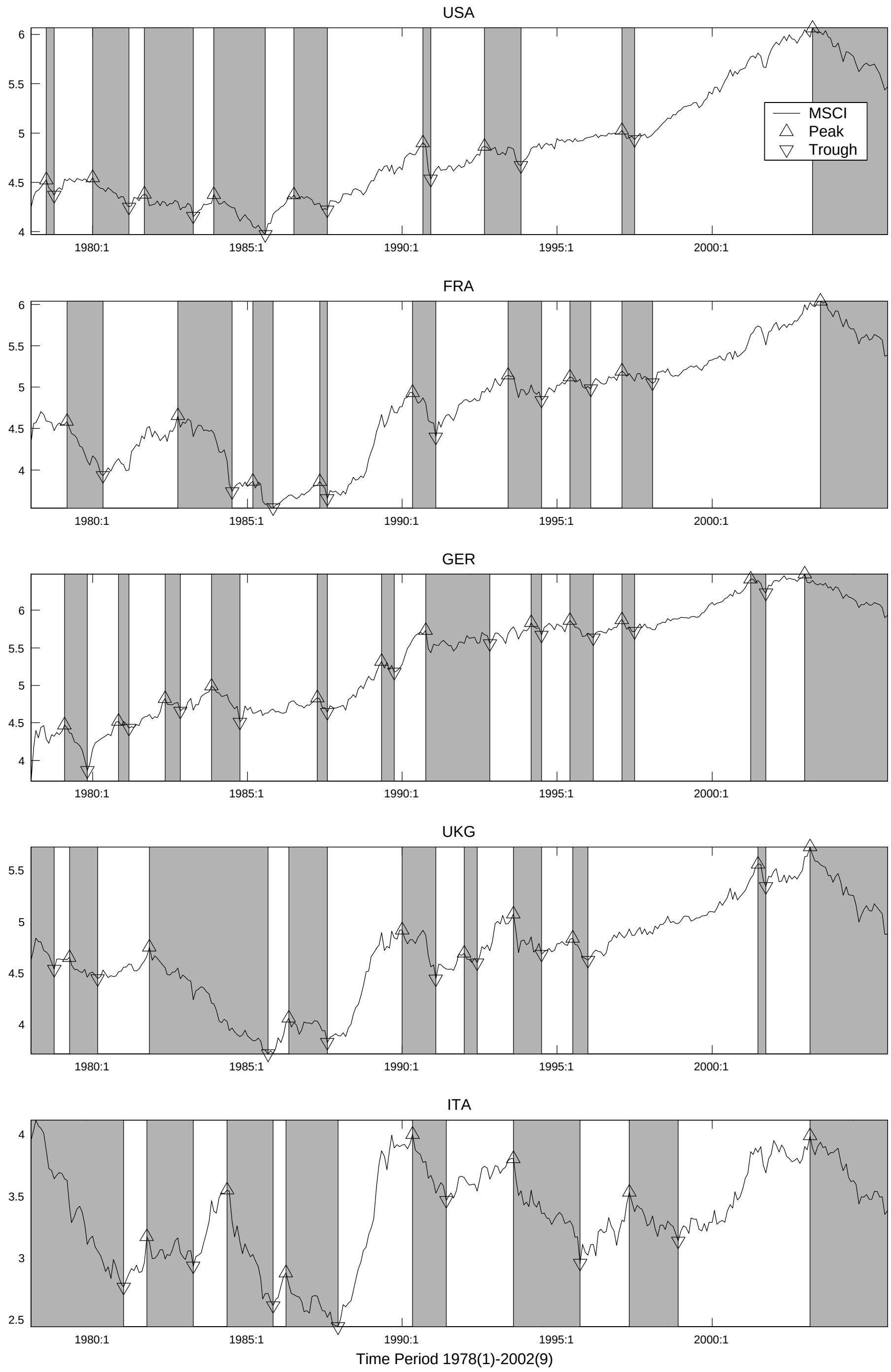

Figure 5: Turning points for MSCI return indeces, 1978(1)-2002(9).

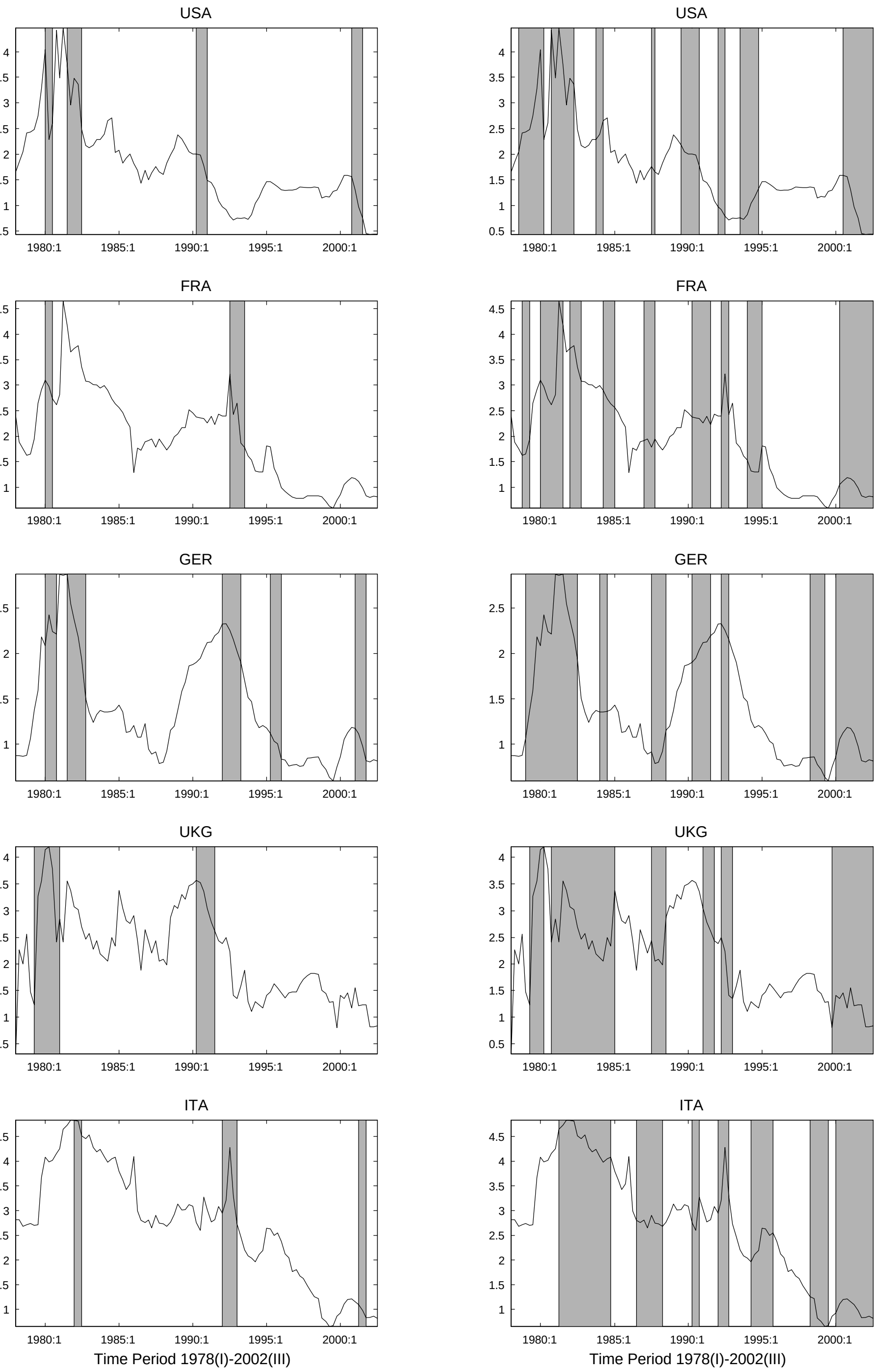

Figure 6: Money rates and GDP's turning points(left column) and return indeces' turning points (right column).

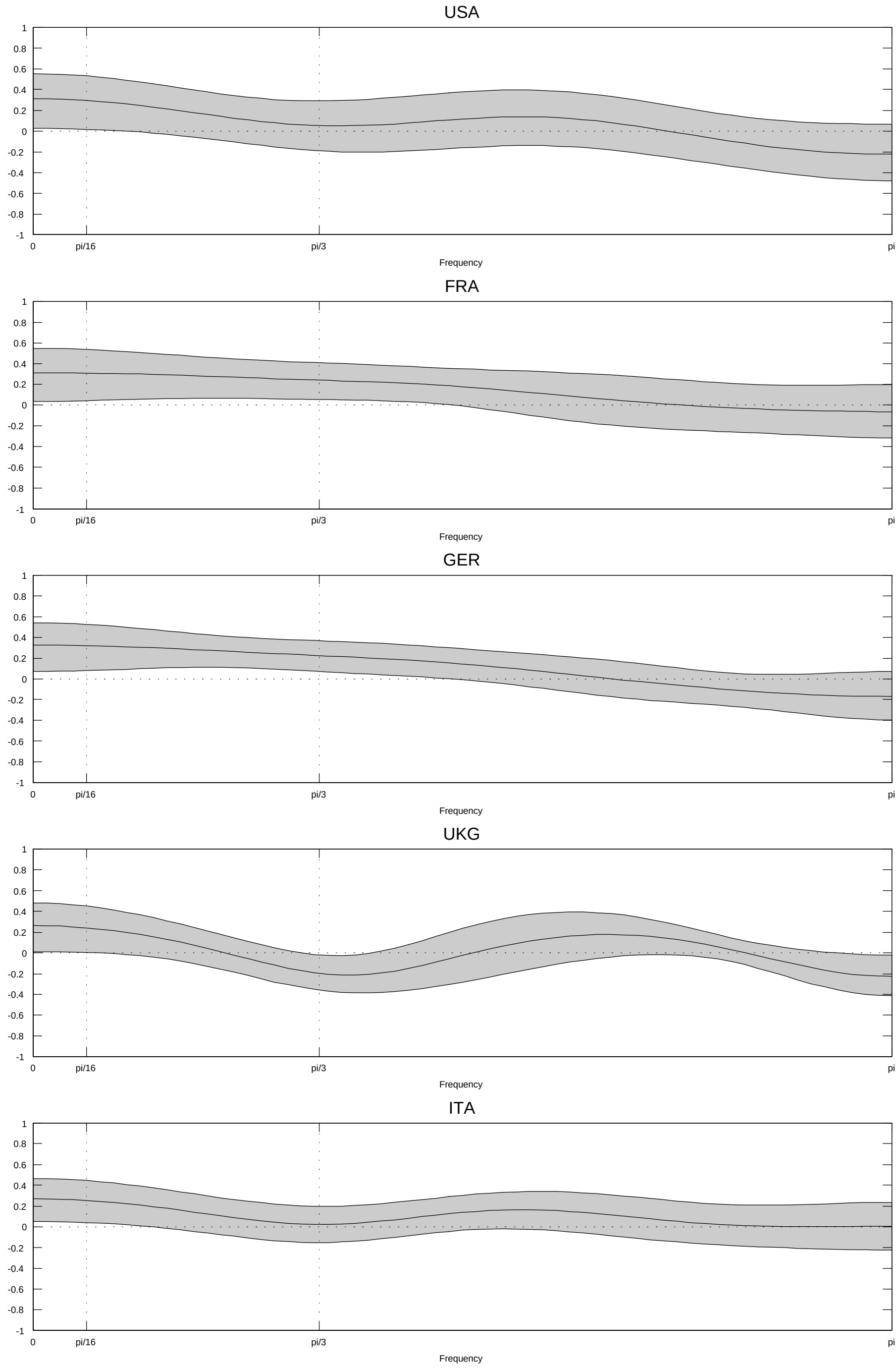

Figure 7: Dynamic correlation between GDP growth and excess returns.

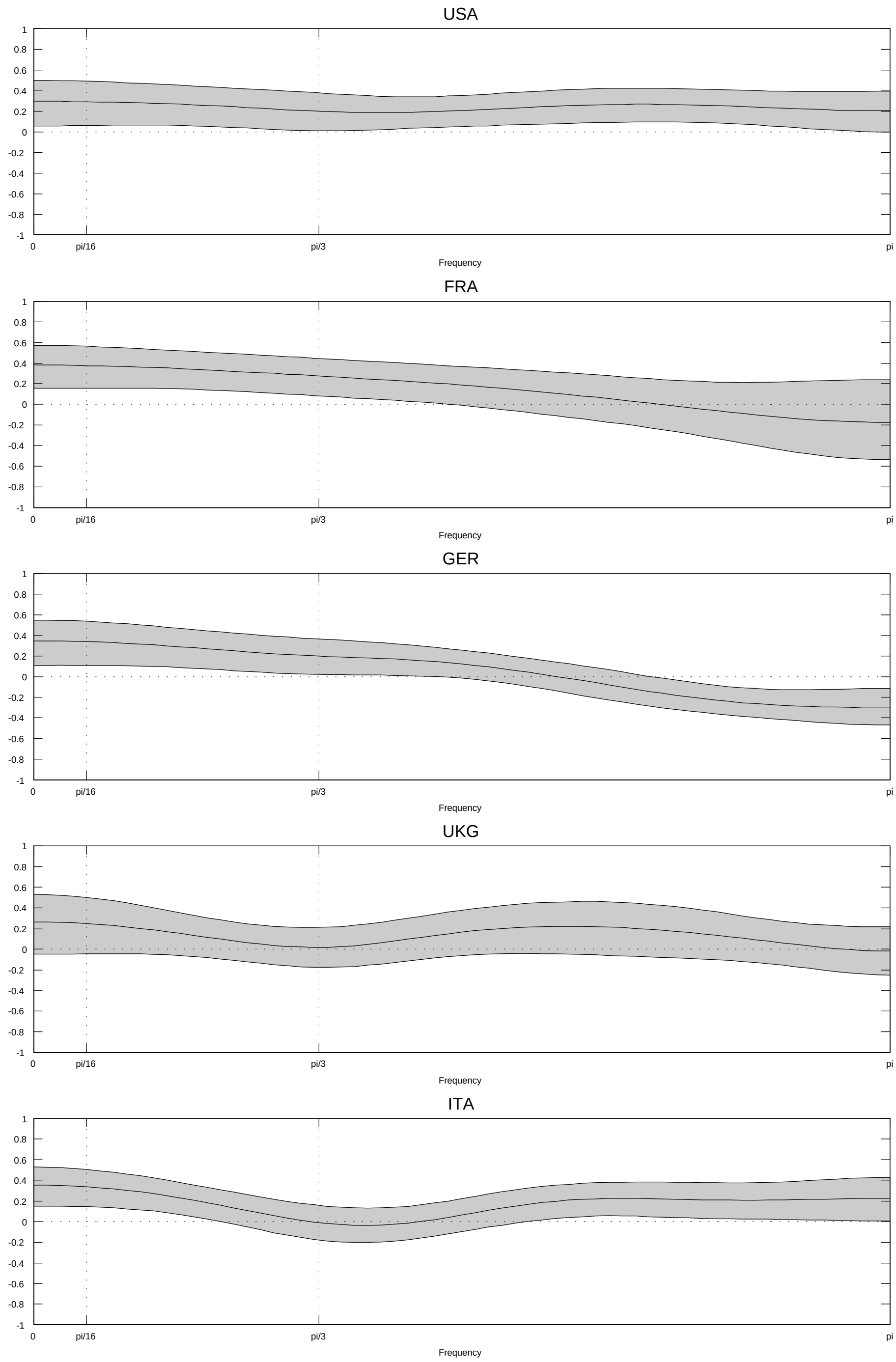

Figure 8: Dynamic correlation between consumption growth and excess returns.

A Identifying Turning points

Bry and Boschan (1971) determined an algorithm that made it possible to replicate the contraction start dates identified by committee of experts from the NBER. We used a variation of this algorithm, developed by Harding and Pagan (2002a,b), whose steps are as follows:

1. A peak/trough is reached at t if the value of the series at date t is superior/inferior to previous k values and to the following k values, where k is a natural integer that varies according to the type of series studied and its sampling frequency.
2. A procedure is implemented to ensure that peaks and troughs alternate, by selecting the highest/lowest consecutive peaks/troughs.
3. Cycles whose duration is shorter than the minimum time m are stripped out, as are cycles whose complete recurrence period (number of periods separating a peak from a peak or a trough from a trough) is lower than the prespecified number of periods M.
4. Complementary rules are applied:
   (a) the first peak/trough cannot be lower/higher than the first point in the series, and the last peak/trough cannot be lower/higher than the last point in the series;
   (b) the first/last peak/trough cannot be positioned at less than e periods from the first/last point in the series studies.

The monthly sales index is prefiltred using a Spencer curve, in accordance with the usual procedure described in the literature. The latter defines the filtered series $\tilde{x}_t$ from the raw series x_t according to

$$\tilde{x}_t = \sum_{i=-7}^{7} s_i x_{t+i}, \quad s_i = s_{-i} \text{ for } i = 1, ..., 7$$

$$s_0 = \frac{74}{320},\ s_1 = \frac{67}{320},\ s_2 = \frac{46}{320},\ s_3 = \frac{21}{320},\ s_4 = \frac{3}{320},\ s_5 = -\frac{5}{320},\ s_6 = -\frac{6}{320},\ s_7 = -\frac{3}{320}.$$

Note that, like Pagan and Sossounov (2003), we do not prefilter the monthly financial series. Moreover, in the latter case, imposing a minimum phase m may be restrictive. Pagan and Sossounov (2003) therefore propose relaxing the constraint on the minimum phase where a fall or a rise in excess of 20% is present in a period. We adopt this procedure here.

A contraction/expansion phase is thus defined as the time separating a peak/trough from a peak/trough, when the sequence of peaks and troughs meets all the identification rules listed above.

Notice that the identification of turning points is very sensitive to the choices of parameters k, e, m, and M: if the latter are set to small values, almost all absolute declines in the level of the series will be identified as troughs, all the more so as the original variable is not too smooth. To the contrary, if these are set to large values, the procedure will come up with almost no turning points.

The choice of k, e, m, and M depends upon the series at study and their sampling frequency. For example, if y denotes logged quarterly GDP, one generally sets $k = 2$, $e = 2$, $m = 2$, and $M = 5$. These values allow us to replicate the NBER business cycle dates.

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