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**INTERNATIONAL COMOVEMENT OF STOCK MARKET RETURNS:  
A WAVELET ANALYSIS**

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# International comovement of stock market returns: a wavelet analysis

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## Abstract

The assessment of the comovement among international stock markets is of key interest, for example, for the international portfolio diversification literature. In this paper, we re-examine such comovement by resorting to a novel approach, wavelet analysis. Wavelet analysis allows one to measure the comovement in the time-frequency space. In this way, one can characterize how international stock returns relate in the time and frequency domains simultaneously, which allows one to provide a richer analysis of the comovement. We focus on Germany, Japan, UK and US and the analysis is done at both the aggregate and sectoral levels.

*Keywords:* International stock markets; Comovement; Wavelets; Time-frequency space.

*JEL classification:* C40, E32, G15, F30.

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# 1 Introduction

The analysis of the comovement of stock market returns is a key issue in finance as it has important practical implications in asset allocation and risk management. Since the seminal work of Grubel (1968) on the benefits of international portfolio diversification (see also, Levy and Sarnat (1970) and Agmon (1972)) this topic has received a lot of attention in international finance. In fact, a growing body of literature has emerged more recently on studying the comovement of international stock prices (see, for example, King *et al.* (1994), Lin *et al.* (1994), Longin and Solnik (1995, 2001), Karolyi and Stulz (1996), Forbes and Rigobon (2002), Brooks and Del Negro (2005, 2006)). In particular, most of those studies have found that the comovement of stock returns is not constant over time. For instance, Brooks and Del Negro (2004) and Kizys and Pierdzioch (2008) found evidence of increasing international comovement of stock returns since the mid-90's among the major developed countries. It has been current practice to evaluate the comovement of stock returns through the correlation coefficient while the evolving properties have been investigated either through a rolling window correlation coefficient (see, for example, Brooks and Del Negro (2004)) or by considering non-overlapping sample periods (see, for example, King and Wadhvani (1990) and Lin *et al.* (1994)).

However, the comovement analysis should also take into account the distinction between the short and long-term investor (see, for example, Candelon *et al.* (2008)). From a portfolio diversification view, the first kind of investor is naturally more interested in the comovement of stock returns at higher frequencies, that is, short-term fluctuations, whereas the latter focus on the relationship at lower frequencies, that is, long-term fluctuations. Hence, one has to resort to the frequency domain analysis to obtain insights about the comovement at the frequency level (see, for example, A'Hearn and Woitek (2001) and Pakko (2004)). One should note that, despite its recognized interest, analysis in the frequency domain is much less found in

the financial empirical literature (see, for example, Smith (2001)).

In this paper, we re-examine the stock returns comovement among the major developed economies through a novel approach, wavelet analysis. Wavelet analysis constitutes a very promising tool as it represents a refinement in terms of analysis in the sense that both time and frequency domains are taken into account. Although wavelets have been more popular in fields such as signal and image processing, meteorology, physics, among others, such analysis can also provide fruitful insights about several economic phenomena (see, for example, Ramsey and Zhang (1996, 1997)). The pioneer work of Ramsey and Lampart (1998a, 1998b) draws on wavelets to study the relationship between several macroeconomic variables (see, for example, Crowley (2007) for a survey). In particular, wavelet analysis provides a unified framework to measure comovement in the time-frequency space.

The study of the comovement of stock market returns is crucial for risk assessment of portfolios. A higher comovement among the assets of a given portfolio implies lower gains, in terms of risk management, stemming from portfolio diversification. Hence, the evaluation of the comovement is of striking importance to the investor so that he can best assess the risk of a portfolio. On one hand, it has been acknowledged that the comovement of stock returns varies over time. Hence, one has to be able to capture this time-varying feature as it implies an evolving risk exposure. On the other hand, the distinction between short and long-term investors should not be ignored as the first is more interested on short-run movements whereas the latter on long-run fluctuations. That is, if the degree of the comovement of stock returns varies across frequencies the risk for each type of investor will also be different. In contrast with time or frequency domain approaches which allow one to focus only on one of these issues, wavelet analysis encompasses both. In particular, through wavelets one can assess simultaneously the strength of the comovement at different frequencies and how such strength has evolved over time. In this way it is possible to identify regions in the

time-frequency space where the comovement is higher and the benefits of portfolio diversification in terms of risk management are lower.

In addition, we also extend such analysis to the sectoral level. That is, besides considering the aggregate stock returns, we also distinguish ten sectors for each country. For the international diversification of equity portfolios, the assessment of the comovement at the sectoral level also plays a role (see, for example, Roll (1992), Heston and Rouwenhorst (1994) and Griffin and Karolyi (1998)). For instance, it is important to assess if the evidence of greater interdependence of international stock markets is confined or not to a small set of sectors (see, for example, Berben and Jansen (2005)). Again, wavelet analysis can provide interesting insights on how such international comovement has evolved over time across frequencies for the different sectors.

Hence, this paper provides a fresh new look into the characterisation of the comovement among international stock returns. We focus on the major developed economies, namely Germany, Japan, United Kingdom and United States over the last four decades. Moreover, by considering the decomposition of the aggregate index in ten sectors, we also provide insights at the sectoral level.

This paper is organised as follows. In section 2, the comovement measure in the wavelet domain is presented. In section 3, a data overview is provided and in section 4 the empirical results for the major developed economies are discussed. Finally, section 5 concludes.

## 2 Wavelet analysis

The wavelet transform decomposes a time series in terms of some elementary functions, the daughter wavelets or simply wavelets  $\psi_{\tau,s}(t)$ . Wavelets are 'small waves' that grow and decay in a limited time period. These wavelets result from a mother wavelet  $\psi(t)$ , that can be expressed as function of the time position  $\tau$  (translation parameter) and the scale  $s$  (dilation para-

meter), which is related with the frequency. While the Fourier transform decomposes the time series into infinite length sines and cosines, discarding all time-localization information, the basis functions of the wavelet transform are shifted and scaled versions of the time-localized mother wavelet. More explicitly, wavelets are defined as

$$\psi_{\tau,s}(t) = \frac{1}{\sqrt{s}}\psi\left(\frac{t-\tau}{s}\right) \quad (1)$$

where  $\frac{1}{\sqrt{s}}$  is a normalization factor to ensure that wavelet transforms are comparable across scales and time series. To be a mother wavelet,  $\psi(t)$ , must fulfil several conditions (see, for example, Gençay *et al.* (2002), Percival and Walden (2000) and Bruce and Gao (1996)): it must have zero mean,  $\int_{-\infty}^{+\infty}\psi(t)dt = 0$ ; its square integrates to unity,  $\int_{-\infty}^{+\infty}\psi^2(t)dt = 1$ , which means that  $\psi(t)$  is limited to an interval of time; and it should also satisfy the so-called admissibility condition,  $0 < C_\psi = \int_0^{+\infty} \frac{|\hat{\psi}(\omega)|^2}{\omega} d\omega < +\infty$  where  $\hat{\psi}(\omega)$  is the Fourier transform of  $\psi(t)$ , that is,  $\hat{\psi}(\omega) = \int_{-\infty}^{+\infty} \psi(t)e^{-i\omega t} dt$ . The latter condition allows the reconstruction of a time series  $x(t)$  from its continuous wavelet transform,  $W_x(\tau, s)$ . Thus, it is possible to recover  $x(t)$  from its wavelet transform through the following formula

$$x(t) = \frac{1}{C_\psi} \int_{-\infty}^{+\infty} \left[ \int_{-\infty}^{+\infty} \frac{1}{\sqrt{s}} \psi\left(\frac{t-\tau}{s}\right) W_x(\tau, s) d\tau \right] \frac{ds}{s^2} \quad (2)$$

The continuous wavelet transform of a time series  $x(t)$  with respect to  $\psi(t)$  is given by the following convolution

$$W_x(\tau, s) = \int_{-\infty}^{+\infty} x(t)\psi_{\tau,s}^*(t)dt = \frac{1}{\sqrt{s}} \int_{-\infty}^{+\infty} x(t)\psi^*\left(\frac{t-\tau}{s}\right) dt \quad (3)$$

where  $*$  denotes the complex conjugate. For a discrete time series,  $x(t)$ ,  $t = 1, \dots, N$  we have

$$W_x(\tau, s) = \frac{1}{\sqrt{s}} \sum_{t=1}^N x(t)\psi^*\left(\frac{t-\tau}{s}\right) \quad (4)$$

Although it is possible to compute the wavelet transform in the time domain using equation (4), a more convenient way to implement it is to carry out the wavelet transform in Fourier space (see, for example, Torrence and Compo (1998)).

The most commonly used mother wavelet is the Morlet wavelet and is defined as

$$\psi(t) = \pi^{-\frac{1}{4}} \left( e^{i\omega_0 t} - e^{-\frac{\omega_0^2}{2}} \right) e^{-\frac{t^2}{2}} \quad (5)$$

Since the term  $e^{-\frac{\omega_0^2}{2}}$  becomes negligible for an appropriate  $\omega_0$ , the Morlet wavelet is simply defined as

$$\psi(t) = \pi^{-\frac{1}{4}} e^{i\omega_0 t} e^{-\frac{t^2}{2}} \quad (6)$$

with the corresponding Fourier transform given by

$$\widehat{\psi}(\omega) = \pi^{\frac{1}{4}} \sqrt{2} e^{-\frac{1}{2}(\omega - \omega_0)^2} \quad (7)$$

One can see that the Morlet wavelet is a complex sine wave within a Gaussian envelope whereas  $\omega_0$  is the wavenumber (see, for example, Adisson (2002) for further details). In practice,  $\omega_0$  is set to 6 as it provides a good balance between time and frequency localization (see, for example, Grinsted *et al.* (2004)).

Given two time series  $x(t)$  and  $y(t)$ , with wavelet transforms  $W_x(\tau, s)$  and  $W_y(\tau, s)$  one can define the cross-wavelet spectrum as  $W_{xy}(\tau, s) = W_x(\tau, s)W_y^*(\tau, s)$ . In a similar fashion as in Fourier analysis, one can define the wavelet squared coherency as the absolute value squared of the smoothed cross-wavelet spectrum, normalized by the smoothed wavelet power spectra

$$R^2(\tau, s) = \frac{|S(s^{-1}W_{xy}(\tau, s))|^2}{S(s^{-1}|W_x(\tau, s)|^2)S(s^{-1}|W_y(\tau, s)|^2)} \quad (8)$$



where  $S(\cdot)$  denotes smoothing in both time and scale (see, for example, Torrence and Webster (1999)). Likewise in Fourier analysis, smoothing is also necessary, otherwise squared coherency would be always equal to one (see, for example, Priestley (1981)).

The intuition behind the wavelet squared coherency is similar to the one of squared coherency in Fourier analysis. As it can be seen from (8), the wavelet squared coherency is essentially the ratio of the squared cross-wavelet spectrum to the product of two wavelet spectra, analogously to the squared coefficient of correlation. In other words, the wavelet squared coherency plays a role as a correlation coefficient around each moment in time and for each frequency. Therefore, one can use wavelet squared coherency to measure the extent to which two time series move together over time and across frequencies (while the squared coherency in Fourier analysis only allows one to assess the latter). Likewise the squared coefficient of correlation,  $R^2(\tau, s)$  is between 0 and 1 with a high (low) value indicating a strong (weak) comovement. Hence, through the graph of the wavelet squared coherency one can detect the regions in the time-frequency space where the two time series co-vary and capture both time and frequency varying features. In this way, it is possible to provide a richer picture on the comovement between two series<sup>1</sup>.

### 3 Data

Stock prices data for the major developed economies, namely, Germany, Japan, United Kingdom and United States are from Thompson Financial Datastream. For each country, we collected Datastream constructed data for the broad-based market price index as well as for the ten economic sectors

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<sup>1</sup>Additionally, one can also compute the wavelet phase, which captures the lead-lag relationship between the variables in the time-frequency space. However, the results are not reported here as no noteworthy lead-lag relationship was found in the empirical application.

that make up the index, namely: Oil and gas; Basic materials; Industrials; Consumer goods; Healthcare; Consumer services; Telecommunications; Utilities; Financials and Technology. Apart from a few exceptions, the sample period runs from January 1973 up to December 2007 comprising 420 monthly observations, end of period figures. The exceptions are: Oil and Gas for Germany was not included in the analysis as the time series span was too short; the Technology index for Germany only starts at December 1988; the Telecommunications index for the UK is available from December 1981 onwards and the Utilities index for the UK only begins at January 1987. We focus on monthly stock returns, defined as the log first difference of monthly stock price indices and we use returns denominated in the home currency of each respective country.<sup>2</sup> In Table 1 some descriptive statistics are presented.

## 4 Empirical results

In this section, wavelet squared coherency is presented for all possible country pairs in order to assess cross-country comovement (namely, US and Germany; UK and Germany; US and UK; Japan and Germany; Japan and US; Japan and UK). The wavelet squared coherency is presented through a contour plot as we have three dimensions involved. The horizontal axis refers to time while the vertical axis refers to frequency. To ease interpretation, the frequency is converted to time units (years). The gray scale is for the wavelet squared coherency where increasing darkness corresponds to an increasing value and mimics the height in a surface plot. Hence, through the inspection of the graph one can identify both frequency bands (in the vertical axis) and time intervals (in the horizontal axis) where the series

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<sup>2</sup>We also performed the analysis using stock prices converted to a common currency and the results do not change qualitatively. The bilateral exchange rates are also from Thompson Financial Datastream.

move together<sup>3</sup>. For example, a dark area at the bottom (top) of the graph means strong comovement at low (high) frequencies whereas a dark area at the left-hand (right-hand) side denotes strong comovement at the beginning (end) of the sample period. Moreover, through such wavelet analysis one can also assess if the comovement has increased or decreased over time and across frequencies capturing possible varying features in the relationship between stock returns in the time-frequency space. The black bold line in the graph delimits the statistical significant area at the usual significance level of five per cent, *i.e.*, the wavelet squared coherency is statistically significant within such delimited time-frequency area. In particular, the five per cent significance level was determined from a Monte Carlo simulation of 10 000 sets of two white noise time series with the same length as the series under analysis. All computations have been done using Matlab.

From the analysis of the results obtained for the broad-based market stock returns several interesting findings arise (see Figure 1). First, Germany presents a relatively high degree of comovement at lower frequencies with US and UK over the whole sample period. Interestingly, since the end of the 90's, this high degree of comovement has been extended to all frequencies. Hence, there seems to be a change in the pattern of the relationship at the end of the 90's, whereas prior to that date the strong comovement is confined only to long-run fluctuations while afterwards it is visible for all sort of fluctuations. This finding provides an additional insight on the fact, commonly found in the recent literature, that there has been an overall increasing comovement.

Second, the US and UK stock markets seem to present a high degree of comovement over the last four decades (see also, for example, Kizys and Pierdzioch (2008)). One can see that this evidence is true for all frequencies but the highest ones. In particular, for fluctuations with a duration less than

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<sup>3</sup>As the continuous wavelet transform at a given point in time uses information of neighbouring data points, results should be read carefully close to the beginning or the end of the time series.

a year the comovement is weaker. However, even at those frequencies one can observe episodes where it is also high, namely around the 1987 US stock market crash and at the turn of the century with the technology bubble.

Third, one can conclude that Japan presents, in general, a low comovement with all the other countries considered. This low comovement of the Japanese stock market with the other major stock markets has also been found elsewhere (see, for example, Berben and Jansen (2005) and Longin and Solnik (1995)). From the current analysis it becomes clear that such evidence seems to be robust to the sample period and across all frequencies.

We now turn to the sectoral analysis.<sup>4</sup> Through an overview of the results some findings immediately emerge. First, the results obtained support the idea of a weak correlation between the Japanese stock market and the other major developed stock markets both across sectors and across time and frequency (see also Berben and Jansen (2005)). However, there are two noteworthy exceptions, namely, in the consumer goods and technology sectors. In both sectors there is evidence of a strong comovement at lower frequencies between Japan and the other countries and in the technology sector, in particular, the comovement between Japan and US and between Japan and UK seems to have increased at other frequencies since the mid-90's.

Focusing now only on Germany, US and UK, one can see that in several sectors there is a strong comovement at long term fluctuations and interestingly, in most sectors, the US and UK stock markets present a temporary strong comovement at higher frequencies around the time of the 1987 US market crash.

Let us now run through the sectoral results in more detail. Regarding the oil and gas sector, there is a strong comovement at several frequencies between US and UK over the whole sample period. In the basic materials

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<sup>4</sup>For each of the ten sectors considered, we computed the squared wavelet coherency for the same country pairs as in Figure 1. To save space such figures are not presented here but are available from the authors upon request.

sector, we find a significant comovement at lower frequencies between US and Germany over the entire sample period as well as between UK and Germany and US and UK since the 90's. Note that between US and UK there is also a strong comovement at fluctuations longer than half a year and shorter than three years since the mid-80's. Concerning industrials, we find evidence of an increasing comovement between US and Germany and between US and UK at lower to medium frequencies range since the 90's (and to a less extent, between UK and Germany since the turn of the century). In the consumer goods sector, there is a significant comovement at lower frequencies for all country pairs. In the healthcare sector, the strongest comovement seems to be between US and UK comprising several frequencies. Regarding consumer services, Germany presents an increasing comovement with both US and UK at the turn of the century for almost all frequencies while US and UK show a strong comovement at the typical business cycle frequency range. In the telecommunications sector, we find a strong comovement at fluctuations longer than four years between UK and Germany and US and UK over almost the whole sample period and between US and Germany since late 80's. Concerning utilities, we find a significant comovement between UK and the other countries at lower frequencies. In the financials sector, Germany presents an increasing comovement with both US and UK since the mid-90's at several frequencies while there is a significant comovement between US and UK over most sample. Finally, in the technology sector, there is evidence of a strong comovement at long-term fluctuations since the 90's for all country pairs whereas US and UK present an increasing comovement at all frequencies since the mid-90's.

In summary, in terms of the aggregate index, among all the country pairs considered, the US and UK stock markets seem to present the highest comovement across time and frequencies while the Japanese market shows a low degree of comovement with any other major stock market in the time-frequency space. Regarding Germany, we find a high degree of comovement

at lower frequencies with US and UK over the whole sample period and since the end of the 90's this is also observed for all the other frequencies. At the sectoral level, the weak comovement of Japan with the other countries is also, in general, present while Germany, US and UK show a significant comovement in several sectors at lower frequencies.

Let us illustrate the importance of wavelet analysis for risk management (see also Gençay *et al.* (2005) and Fernandez (2005, 2006)). To highlight the implications of the above findings, we perform a Value at Risk (VaR) analysis. The VaR is a widely known tool for risk assessment and it can be interpreted as the maximum loss of a portfolio not exceeded with a given probability over a period of time. The VaR at the  $(1 - \alpha)$  percent confidence level of a portfolio of  $k$  assets can be written as

$$VaR(\alpha) = V_0 \Phi^{-1}(1 - \alpha) \sigma_p \quad (9)$$

where  $V_0$  is the value of the initial investment,  $\Phi(\cdot)$  is the cumulative distribution function of the standard Normal and  $\sigma_p$  is the square root of the portfolio variance. For a portfolio of  $k$  assets, the portfolio variance is given by

$$\sigma_p^2 = \sum_i \omega_i^2 \sigma_i^2 + \sum_i \sum_{j \neq i} \omega_i \omega_j Cov(r_i, r_j) \quad i, j = 1, \dots, k \quad (10)$$

where  $\omega_i$  is the weight of asset  $i$  in the portfolio,  $r_i$  is the return of asset  $i$  and  $\sigma_i^2$  is the corresponding variance. From (10) one can see that the portfolio variance can be decomposed into two terms whereas the first one is strictly related with the variance of stock returns while the second term reflects the comovement. To make clear the importance of the comovement for risk assessment, we compute the VaR of a portfolio assuming that there is no comovement between the assets and the VaR of the same portfolio but without this restriction. In practice, we compute the portfolio variance discarding the second term of (10) in the former case while considering both terms in the latter case. To ease the comparison of the two VaR, we compute

the ratio between them which resumes to the ratio of portfolio variances. In this way, one can assess the percentage increase/decrease in the VaR due to comovement. If the ratio is equal to one then it means that the comovement does not change the VaR while if the ratio is higher (lower) than one then it means that the comovement implies a higher (lower) VaR.

Let us consider an equally-weighted portfolio, whose value is measured in US dollars, comprised by the four country broad-based market indices. Resorting to the wavelet counterparts of variance and covariance in (10), we computed the above mentioned ratio in the time-frequency space (see Figure 2). Firstly, one can see that the ratio is almost always higher than one. That is, whatever the frequency or the moment in time, the comovement among country stock returns implies a higher VaR. Naturally, from a portfolio perspective, a positive comovement among stock returns increases risk. Moreover, as expected, given the results above discussed, the comovement has a different impact in the VaR across frequencies and time. One can see that the ratio is higher at low frequencies over the whole sample period (the VaR is higher around 80 per cent) and it has increased over time attaining higher values at all frequencies in the latter part of the sample period. This evidence reinforces the above findings regarding the fact that the benefits of international portfolio diversification vary across frequencies and over time.

## 5 Conclusions

The assessment of the international comovement of stock returns is crucial so as to shed light, for example, on the potential benefits of international portfolio diversification. This paper provides a new look into the comovement measurement of stock returns by resorting to wavelet analysis. Wavelet analysis allows one to assess the time- and frequency-varying comovement within an unified framework. This analysis is of particular interest in the context of the study of stock returns comovement as it is by now a stylized fact that the degree of comovement has changed over time and because

one should be able to take into consideration the distinction between the short- and long-term investor, that is, the frequency domain. In fact, with wavelet analysis one can take into account the time and frequency domains simultaneously.

In this paper, we consider the stock returns for the major developed countries, namely Germany, Japan, United Kingdom and United States over the last four decades and besides the aggregate index we also consider its decomposition in ten main sectors, so as to provide insights at the sectoral level. A noteworthy finding of this paper is that the strength of the comovement of international stock returns depends on the frequency. In general, we find that comovements between markets is stronger at the lower frequencies suggesting that the benefits from international diversification may be relatively less important in the long-term than in the short-term. Therefore, the nature of the investor, in terms of short or long-term profile, should be taken into account when addressing the international portfolio diversification problem. We also found that the strength of the comovement in the time-frequency space varies across countries as well as across sectors. For instance, even though the Japanese stock market is generally weakly correlated with the other developed countries stock markets considered (as in Berben and Jansen, 2005), there are some sectors (technology and consumer goods) displaying strong comovements at particular frequencies and time periods. Finally, it was also found that the degree of comovement has changed over time, in line with the findings of Brooks and Del Negro (2004), among others. However, such changes are found to be confined, in several cases, to particular frequency ranges. Moreover, the detected changes are of different natures regarding their persistence in time. For example, the degree of comovement of the German market with the US and UK markets is characterized by some permanent changes over time: a gradual but steady increase of the comovement at the lower frequencies, and also a sudden increase after the end of the nineties for the other frequencies. On the other hand, the



episodes of stronger comovement at higher frequencies between the US and UK markets around the 1987 crash and at the end of the century technological bubble are clearly of a distinct transitory nature. The first phenomena may be explained by the increased integration of financial markets whereas the latter may be associated with contagion. All these results highlight the importance of taking into consideration the time and frequency-varying properties of stock returns comovement in designing international portfolios as it may influence the benefits of international portfolio diversification in a non-negligible way.

## References

- [1] Adisson, P. (2002) "The illustrated wavelet transform handbook", The Institute of Physics, London.
- [2] Agmon, T. (1972) "The relations among equity markets: A study of share price co-movements in the United States, United Kingdom, Germany and Japan", *Journal of Finance*, vol. 27, no. 4, 839-855.
- [3] A'Hearn, B. and Woitek, U. (2001) "More international evidence on the historical properties of business cycles", *Journal of Monetary Economics*, 47, 321-346.
- [4] Berben, R. P. and Jansen, W. J. (2005) "Comovement in international equity markets: A sectoral view", *Journal of International Money and Finance*, 24, 832-857.
- [5] Brooks, R. and Del Negro, M. (2004) "The rise in comovement across national stock markets: market integration or IT bubble?", *Journal of Empirical Finance*, 11, 659-680.

- [6] Brooks, R. and Del Negro, M. (2005) "Country versus region effects in international stock returns", *Journal of Portfolio Management*, Summer 2005, 67-72.
- [7] Brooks, R. and Del Negro, M. (2006) "Firm-level evidence on international stock market comovement", *Review of Finance*, 10, 69-98.
- [8] Bruce, A. and Gao, H. (1996) "Applied wavelet analysis with S-Plus", Springer.
- [9] Candelon, B., Piplack, J. and Straetmans, S. (2008) "On measuring synchronization of bulls and bears: The case of East Asia", *Journal of Banking and Finance*, 32, 1022-1035.
- [10] Crowley, P. (2007) "A guide to wavelets for economists", *Journal of Economic Surveys*, vol. 21, no. 2, 207-264.
- [11] Fernandez, V. (2005) "The international CAPM and a wavelet-based decomposition of value at risk", *Studies in Nonlinear Dynamics & Econometrics*, vol. 9, no. 4, Article 4.
- [12] Fernandez, V. (2006) "The CAPM and value at risk at different time-scales", *International Review of Financial Analysis*, 15, 203-219.
- [13] Forbes, K. and Rigobon, R. (2002) "No contagion, only interdependence: Measuring stock market comovements", *Journal of Finance*, vol. 57, 2223-2261.
- [14] Gençay, R. , Selçuk, F. and Whitcher, B. (2002) "An introduction to wavelets and other filtering methods in finance and economics", Academic Press, London.
- [15] Gençay, R. , Selçuk, F. and Whitcher, B. (2005) "Multiscale systematic risk", *Journal of International Money and Finance*, 24, 55-70.

- [16] Griffin, J. and Karolyi, G. (1998) "Another look at the role of the industrial structure of markets for international diversification strategies", *Journal of Financial Economics*, 50, 351-373.
- [17] Grinsted, A., Moore, J. C. and Jevrejeva, S. (2004) "Application of the cross wavelet transform and wavelet coherence to geophysical time series", *Nonlinear Processes in Geophysics*, 11, 561-566.
- [18] Grubel, H. (1968) "Internationally diversified portfolios: welfare gains and capital flows", *American Economic Review*, vol. 58, no. 5, 1299-1314.
- [19] Heston, S. and Rouwenhorst, K. (1994) "Does industrial structure explain the benefits of international diversification?", *Journal of Financial Economics*, 36, 3-27.
- [20] Karolyi, G. A. and Stulz, R. M. (1996) "Why do markets move together? An investigation of U.S.-Japan stock return comovements", *Journal of Finance*, vol. 51, no. 3., 951-986.
- [21] King, M., Sentana, E. and Sushil, W. (1994) "Volatility and links between national stock markets", *Econometrica*, vol. 62, no. 4, 901-933.
- [22] King, M. and Wadhvani, S. (1990) "Transmission of volatility between stock markets", *Review of Financial Studies*, vol. 3, no. 1, 5-33.
- [23] Kizys, R. and Pierdzioch, C. (2008) "Changes in the international comovement of stock returns and asymmetric macroeconomic shocks", forthcoming in *Journal of International Financial Markets, Institutions and Money*.
- [24] Levy, H. and Sarnat, M. (1970) "International diversification of investment portfolios", *American Economic Review*, vol. 60, no. 4, 668-675.

- [25] Lin, W.-L., Engle, R. and Ito, T. (1994) "Do bulls and bears move across borders? International transmission of stock returns and volatility", *Review of Financial Studies*, vol. 7, no. 3, 507-538.
- [26] Longin, F. and Solnik, B. (1995) "Is the correlation in international equity returns constant: 1960-1990?", *Journal of International Money and Finance*, vol. 14, no. 1, 3-26.
- [27] Longin, F. and Solnik, B. (2001) "Extreme correlation of international equity markets", *Journal of Finance*, vol. 56, no. 2, 649-676.
- [28] Pakko, M. (2004) "A spectral analysis of the cross-country consumption correlation puzzle", *Economics Letters*, 84, 341-347.
- [29] Percival, D. and Walden, A. (2000) "Wavelet methods for time series analysis", Cambridge University Press.
- [30] Priestley, M. B. (1981) Spectral analysis and time series, Vols. I and II, Academic Press, London.
- [31] Ramsey, J. and Lampart, C. (1998a) "Decomposition of economic relationships by time scale using wavelets", *Macroeconomic dynamics*, 2(1), 49-71.
- [32] Ramsey, J. and Lampart, C. (1998b) "The decomposition of economic relationships by time scale using wavelets: expenditure and income", *Studies in Nonlinear Dynamics and Econometrics*, vol. 3, no 1, 23-42.
- [33] Ramsey, J. and Zhang, Z. (1996) "The application of wave form dictionaries to stock market index data" in *Predictability of complex dynamical systems* ed. Kratsov, Y. and Kadtke, J., Springer.
- [34] Ramsey, J. and Zhang, Z. (1997) "The analysis of foreign exchange data using waveform dictionaries", *Journal of Empirical Finance*, 4, 341-372.

- [35] Roll, R. (1992) "Industrial structure and the comparative behaviour of international stock market indices", *Journal of Finance*, vol. 47, no. 1, 3-41.
- [36] Smith, K. (2001) "Pre- and post-1987 crash frequency domain analysis among Pacific rim equity markets", *Journal of Multinational Financial Management*, 11, 69-87.
- [37] Torrence, C. and Compo, G. (1998) "A practical guide to wavelet analysis", *Bulletin of the American Meteorological Society*, vol. 79, no. 1, 61-78.
- [38] Torrence, C. and Webster, P. J. (1999) " Interdecadal changes in the ENSO-monsoon system", *Journal of Climate*, 12, 2679-2690.

**Table 1 - Descriptive statistics of monthly stock returns**

	Germany					US					UK					Japan				
	No. equities	Mean	St. Dev.	Skewness	Kurtosis	No. equities	Mean	St. Dev.	Skewness	Kurtosis	No. equities	Mean	St. Dev.	Skewness	Kurtosis	No. equities	Mean	St. Dev.	Skewness	Kurtosis
Total	250	0,01	0,05	-0,87	3,29	992	0,01	0,04	-0,63	2,77	547	0,01	0,06	0,22	9,48	1000	0,00	0,05	-0,27	1,57
Oil and gas	11	0,00	0,08	-0,75	0,29	87	0,01	0,05	0,00	1,13	25	0,01	0,07	0,29	5,40	11	0,00	0,08	-0,01	1,64
Basic materials	20	0,01	0,05	-0,53	1,35	48	0,01	0,06	-0,40	2,63	27	0,01	0,07	-0,32	3,67	102	0,00	0,06	-0,18	1,29
Industrials	62	0,01	0,06	-0,56	1,73	165	0,01	0,05	-0,52	3,22	111	0,01	0,07	-0,26	4,41	223	0,00	0,06	-0,43	1,56
Consumer goods	30	0,00	0,07	0,15	5,96	91	0,00	0,06	-0,67	2,98	35	0,00	0,08	-0,34	2,84	186	0,01	0,06	-0,29	0,99
Healthcare	18	0,01	0,04	-0,51	1,98	97	0,01	0,05	-0,21	2,98	18	0,01	0,06	0,05	8,01	50	0,01	0,05	-0,29	2,04
Consumer services	23	0,00	0,06	-0,50	2,39	123	0,01	0,06	-0,67	3,21	81	0,01	0,06	0,04	6,71	163	0,00	0,05	-0,23	1,70
Telecommunications	1	0,00	0,08	-0,44	3,54	17	0,00	0,05	-0,11	2,33	7	0,01	0,07	-0,24	1,16	7	0,01	0,09	1,12	2,99
Utilities	10	0,01	0,04	0,08	0,86	63	0,00	0,04	-0,13	1,25	10	0,01	0,05	-0,15	1,19	20	0,00	0,06	0,76	5,60
Financials	58	0,01	0,06	-0,78	4,21	205	0,01	0,05	-0,30	2,20	206	0,01	0,06	0,13	6,77	165	0,00	0,07	0,31	2,29
Technology	17	0,02	0,11	-0,43	2,72	96	0,01	0,07	-0,48	1,93	27	0,01	0,10	-0,37	2,78	73	0,00	0,08	-0,05	0,74

Figure 1 - Wavelet squared coherency for the overall stock market

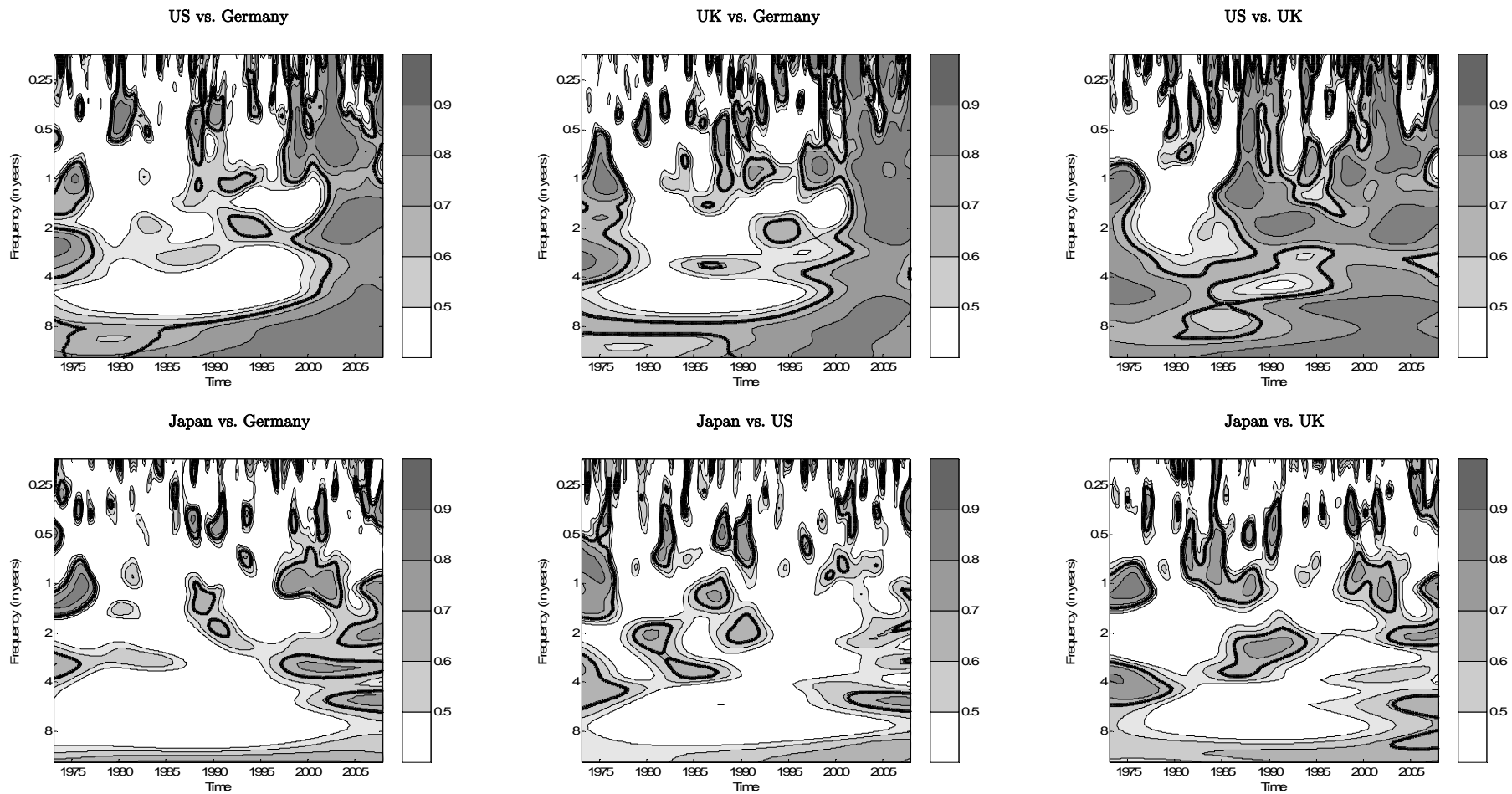
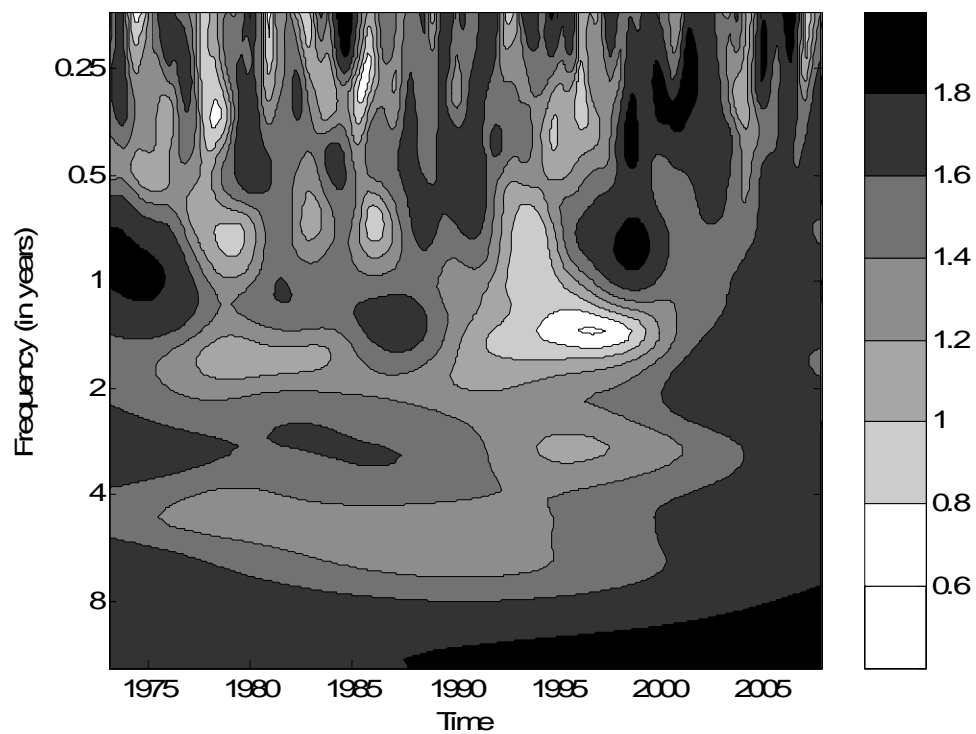


Figure 2 - Ratio between the VaR of a multi-country portfolio with and without comovement





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