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Stability Pact and Interest rate Spillovers: Evidence from two EU Countries

by

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1. Introduction

In the EU region, the prevalence of the new economic order, as reflected by both the Maastricht criteria and the stability pact, has been the subject of intense debate within the academic community. Despite heavy criticism of the deflationary nature of the convergence rules, the architects of the EMU were swift to reassert their authority, by introducing a new, more stringent set of rules and procedures (the stability pact) as a means of promoting fiscal discipline inside EMU. Arguably, the primary aim of the stability pact is to clarify and reinforce the deficit rule laid out in the Maastricht Treaty.

The objective of this paper is to advance the theoretical arguments of those who posit that the causality of interest rate spillovers runs from large in magnitude economies to small ones rather than the other way round, and test this hypothesis by subjecting two representative EU economies, those of Germany and Italy, to rigorous econometric investigation. It should be emphasized that within the EU region Germany is a leading economy whereas Italy is a relatively smaller one. In doing it, one of the fundamental principles of the Stability pact will provide the platform on which our argument will unfold. In particular, as one of the reasons put forward in defence of the Stability pact was presumably to prevent interest rate spillovers across EU countries we feel that drawing on the rationale behind its implementation will give us a more insightful understanding of the way economic policy has been conducted over recent years within the EU region.

For our econometric investigation we estimate various possible univariate autoregressive GARCH (AR-GARCH) models for the two

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interest rate series, and use the optimal lag-length algorithm of the Akaike and Bayesian information criteria to determine the order of the AR-GARCH process. Following Cheung and Ng (1996), we use the cross correlations obtained from these univariate estimations to test for causal relationships between the interest rate of the two countries. The sample cross-correlation statistics reveal useful information on the interaction between the two time series and on their causation patterns. We then use this information to construct models that are more effective in capturing the dynamics of the data.

The estimation of univariate (augmented) AR-GARCH models can be regarded as a first step in the construction of a bivariate model for the German and Italian interest rates. On the one hand, we can use the lag structure revealed by the univariate models to select the optimal lag order of the bivariate model, and on the other hand, we can exploit the information obtained from the cross correlations to build the appropriate bivariate specification. Although we expect the causal relationships derived from the bivariate model to be similar to those uncovered by the univariate estimation, a correctly specified bivariate model will be more precise in capturing the feedback effects between the German and Italian interest rates.

We should also mention that Uctum (1999) adopted an error-correction vector autoregression (ECM-VAR) analysis to investigate the block exogeneity assumption among three European countries and the United States. He found that the Granger causality tests did not confirm the German dominance hypothesis (GDH)[1] when the analysis was conducted with short rates. Hassapis et al. (1999) also examined the interest rate linkages among EMS countries, Germany and the US in a trivariate context, and found that the German rate affects each of the EMS rates and is affected by them.

Even though this paper's intention is far from drawing conclusions regarding the entire EU region we feel that the emerging evidence will at least mirror a significant relationship which is bound to exist amongst the rest of the EU member states. Our paper is organized as follows. Section 2 provides the context for our analysis. By spelling out the reasons for the introduction of the Stability pact we present different views as to why the belief in potential interest rate spillovers across EU countries may by

1. Earlier researchers used the terms asymmetry and dominance to describe the relationship between the EMS members and Germany (see Uctum, 1999).

unfounded. Section 3 engages in the empirical investigation by discussing the two econometric approaches employed to examine the mean and variance causal relationships between the two time series. Section 4 presents the estimated models and elaborates on our results. Section 5 proposes possible extensions and Section 6 concludes.

2. Making Sense of the Stability Pact

In the EU region, the new policy mix fostered by the European governments, especially after the ratification of the Maastricht Treaty, has been directed to ensuring price stability and sound government finances. The emerging feature of this new state of affairs is the new framework (EMU)[2] within which macroeconomic policies in Europe will be pursued.

According to the principles of EMU, at national level, monetary autonomy is transferred to a supranational, independent authority, the European central bank, whereas budgetary policy autonomy is maintained at the national level. However, it is interesting to note that the co-ordination of the budgetary policy within the EU region will be subject to the rules enshrined in the stability and growth pact. According to Keller (1999), the existing economic interdependence between member states necessitates the introduction of a set of rules –such as the ones embodied in the stability pact– that provides the platform on which the co-ordination of budgetary policies will be conducted. In principle, the primary objective of the stability pact is twofold: firstly, it sets the disciplinary budgetary boundary within which budget deficits are allowed to fluctuate, hence its preventative element; and secondly it lays out the rules for correction purposes, should any member state exceed the prescribed deficit threshold. In other words, its chief focus will be on safeguarding the credibility of monetary policy both in the short and long run[3].

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2. In some recent studies aiming to compare and contrast the emerging edifice of EMU with the already established one in the USA, a number of major differences have been identified which possibly may pose some serious threats to the viability of the European Monetary Union. For a more comprehensive analysis on this see: Eichengreen (1990), Goldstein and Woglom (1992).
3. The existing literature on the credibility of monetary policy proposes the delegation of policy to an independent central bank, which is either more conservative than the population (Rogoff, 1985), or subject to an inflation performance contract (Walsh, 1985) as

Prior to embarking on any further exploration of the pact's provisions let us, very succinctly, identify the main elements that this set of regulations and procedures consists of: (i) the budgetary positions of member states should be close to balance or in surplus; (ii) member states should ensure that the deficit criterion, 3 per cent of GDP, is met unless there are special circumstances; (iii) fines will be levied on any EU country that breaches the 3 per cent of GDP deficit ceiling.

The interesting aspect, however, of the above set of rules that deserves attention is the allowances that the pact makes with regard to the member states that fail to conform to its principles. The pact states that a country's qualification for automatic exemption will be subject to its economic performance. More specifically, exemption will be granted to those countries in which GDP has decreased by 2 per cent and its excess budget deficit is transitory and of a small magnitude. Those in which GDP decreases by between 0.75 per cent and 2 per cent could also qualify for exemption provided that the Council of Ministers have agreed. As for those member states which experience an even milder recession, a correction directive will be delivered to them in order to eliminate excessive deficits within two years. Any failure to do so will result in the imposition of fines[4].

Clearly, putting together a set of regulations and procedures by which the member states have to abide is a practice that aims at achieving certain objectives.

What are these objectives?

- To prevent inflationary pressures within the EU region (debt bailouts)[5].
- To avoid spillovers from irresponsible budgetary policies inside EMU.
- To encourage policy co-ordination.
- To increase national saving.

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a solution to time-inconsistency problems of monetary policy in isolation. It does not however say much on the effects of fiscal policy on the behaviour of the central bank and the inflation process (Artis and Winkler, 1997).

4. It should be stressed that the fines for the first three years will take the form of a returnable deposit (non interest bearing). It will not be until this time period has elapsed that the fine will be collected. Sawyer (1999) argues that the imposition of penalties is likely to add to the deficit problem.
5. Eichengreen and Wyplosz (1998, p.79) believe that 'the most compelling rationale for the Stability Pact rests on the need to buttress the no-bailout rule of the Maastricht Treaty'.

Arguably, monetary and budgetary policies should work in the same direction so that low inflation and sustainable growth can be achieved. A bad concoction of policies[6] may lead to high real interest rates, low investment and slow economic growth (Debrun 1997).

According to the stability pact it is important that EU's economies are safeguarded against potential debt-bailouts; this scenario involves a country that has accumulated an obscene amount of debt which it finds impossible to service. As a result the pressure is either on the monetary authority (ECB) to accommodate the debt[7] or on the rest of the member states to bailout the country in distress. "Under these circumstances, the central bank would find it difficult to credibly commit itself to price stability and other members would find their own incentives for implementing sound fiscal policies distorted" (Goldstein and Woglom 1992; p.228). Giavazzi and Pagano (1995) maintain that large deficits undermine the effectiveness of monetary policy and make public finances more fragile. Therefore, balanced or in surplus budgets will enable the entire region to reduce the deadweight cost of taxation and make funding social security liabilities a lot easier[8].

Fundamentally, in neoclassical economics economic growth is contingent on savings (Cesaratto 1999). Thus, the current economic practice of targeting balanced budgets[9] is based on the very notion that budget deficits absorb national saving, and raise interest rates, which in turn crowd out private investment[10].

Recently, within European circles there has been much speculation

6. Referring to a policy mix of loose fiscal policy and tight monetary policy.
7. Growing nominal debt can subvert the central bank's anti-inflationary stance, in that it might be tempted to inflate away the stock of debt (De Grauwe, 1996).
8. According to post-Keynesian analysis, limits imposed on national budget deficits will undermine the positive role that deficits play in stabilizing demand over the business cycle (Sawyer 1999).
9. Three of the most prominent principles of the new macroeconomic orthodoxy are: the government's orientation towards balanced budgets, the notion that government intervention in product, financial, and product markets is economically inefficient; and finally, government interference in financial movements has to be curtailed (Epstein and Gintis, 1995).
10. Such a belief, however, is based on the implicit assumption that monetary policy will be left unchanged as fiscal policy is eased.

regarding the possibility of negative spillovers flowing from irresponsible national budgetary policies[11]. Admittedly, uncontrollably large budget deficits within the EU region can affect interest as well as exchange rates, which in turn can result in crossborder spillovers. Co-ordination of national budgetary policy is therefore needed to ensure that such spillovers are kept at bay as well as to provide a safety margin that allows automatic stabilisers to operate effectively when the economy is in recession (Keller 1999).

Despite the multitude of reasons put forward by the pioneers of the stability pact to justify its introduction, some scepticism[12] regarding its effectiveness has started to emerge. A case in point is Buiter's (1999) qualms regarding the degree of co-ordination between monetary and fiscal policy in the EU region. Invoking the mistrust[13] rooted within the different groups in the ECB's top independent agents, he contends that co-ordination between the ECB and the 11 national finance ministers will be an interesting challenge, the impact of which is yet to be felt. Artis and Winkler (1997) maintain the main inspiration for the fiscal criteria is to assist the ECB in the pursuit of price stability. However, monetary policy will be unable to deal with intra-Union asymmetric shocks. Moreover, Eichengreen and Wyplosz (1998) argue that in a region such as the EU, where capital is mobile, and EU member states borrow on global capital markets, there is little reason why it should result in cross-border interest rate spillovers. Externalities such as fiscal spillovers[14] are conditional on whether the sum of national investment and the deficit exceeds national saving (Pisani-Ferry, 1996). In addition, it has been argued that at national level the stability pact[15] could have an

11. Thygesen (1996) argues that actual deficits are 'an expression of the burden on financial markets'.
12. Arestis & Sawyer (1999) propose the introduction of a new "Stability and Growth Pact, the focus of which will be a common fiscal policy, along with the ECB monetary policy"(p.11).
13. "The Germano-Dutch wing of the ECB mistrusts the Euro XI as an attempt to undermine the operational independence of the central bank" (Buiter 1999, p.205)
14. von Hagen and Eichengreen (1996) maintain that fiscal spillovers depend on the degree of trade or financial integration rather on monetary union.
15. On the political front additional scepticism regarding the economic viability of the Stabilitym Pact can be detected in the announcement, prior to the Amsterdam summit, made by Dominique Strauss-Kahn, Jospin's finance minister, in which he stated that he would not sign a Stability pact devoid of measures to stimulate employment.

adverse effect on the operation of automatic stabilisers, especially when they are most needed, as well as on output[16].

Taking the preceding analysis into account, it can be very confidently argued that the rationale behind the implementation of the stability pact has been far from lucid. In the following sections an attempt will be made to put some of the aforementioned convictions to the test, in order to gain some further insight into the ongoing debate regarding this new set of regulations and procedures.

3. Methodological Issues

The prospect of interest rate spillovers within the EU region has been central to much of the debate that favours the safeguarding attributes of the Stability Pact. A few years ago, Eichengreen and Wyplosz (1998) attempted to provide some evidence with regard to the likelihood that such spillovers will occur within the EU area. Furthermore, Buiter (1999) maintains that since the EU member states borrow on global capital markets there is little need to put in place an entire mechanism presumably to avert cross-border interest rate spillovers.

In pursuing the development of this issue it is essential that econometric analysis be summoned. Prior to engaging in the empirical investigation it is imperative that we look at some methodological issues pertinent to the econometric techniques that we will be pursuing.

Cheung and Ng (1996) proposed a two-stage procedure to examine mean and variance causal relationships between two time series. In the first step, univariate stochastic processes are employed to model the time variation in both the mean and variance of the data. The second step involves (i) the construction of the standardized and squared standardized residuals from the estimated specifications, and (ii) the computation of the cross correlations (at various leads and lags) of these residuals. The estimated cross correlation function (CCF) is subsequently used to test the null hypothesis of no causality in the conditional mean and variance equations.

16. For more on the effects of the restrictions imposed by the Stability pact on automatic stabilizers as well as on output volatility see Bayoumi & Eichengreen (1995); von Hagen & Eichengreen (1996).

Depending on the type of models selected, a mean (variance) causal relationship can exist with or without causality in the variance (mean). Cheung and Ng showed that the revealed patterns of causality in mean and variance can be exploited to provide a more accurate assessment of the temporal dynamics and interaction between the variables under consideration.

In the presence of conditional heteroscedasticity, Vilasuso (2001) investigated the reliability of causality tests based on least squares. He demonstrated that when conditional heteroscedasticity is ignored, least squares causality tests exhibit considerable size distortion if the conditional variances are correlated. In addition, inference based on a heteroscedasticity and autocorrelation consistent covariance matrix constructed under the least squares framework offers only slight improvement. Therefore, he suggested that causality tests should be carried out in the context of an empirical specification that models both the conditional means and conditional variances.

The two step approach of Cheung and Ng (1996) has certain advantages over some alternative tests for causality in variance. Compared with a multivariate method, the CCF methodology is straightforward and simple to implement since it does not require the simultaneous modeling of both intra- and inter-series dynamics. One needs to bear in mind that the uncertainty about the dynamic structure of the mean and variance equations and the potential interaction between the series further complicates the estimation of a multivariate GARCH model. So it is quite challenging to select a multivariate model that adequately captures the dynamic characteristics of the series. In this respect, the utility of the CCF test becomes apparent when the number of series under investigation is large and long lags in the causation pattern are expected. Another appealing feature of the CCF test is that it has a well defined asymptotic distribution and is robust to distributional assumptions.

4. Empirical Analysis

4.1. *Data*

Our data set consists of quarterly observations on short-term interest rates obtained from the Datastream database. The sample period is the first quarter of 1970 through the second quarter of 2001. The three month FIBOR and Discount Rate time series are used for Germany and Italy, respectively, and are plotted in figures 1a-1b.[17] The drop in the level of interest rates since 1992 coincides with the Maastricht treaty.

We examine the stationarity properties of our data using the test proposed by Kwiatkowski, Phillips, Schmidt and Shin (1992) (KPSS). The results of the KPSS tests, together with summary statistics, are reported in table 1 indicating that we can treat the two interest rates as stationary processes. Table 2 presents the sample autocorrelations of the deviations and squared deviations of the interest rates from their sample means. The correlograms and their Q– statistics signify the presence of serial correlation and the existence of ARCH effects in the series.

4.2. *AR-ARCH Models*

Let r_{jt} represent interest rate in period t for country j, which follows an autoregressive (AR) process

$$r_{jt} = c_j + \sum_{l=1}^{p} \Phi_{jl} r_{j,t-l} + \varepsilon_{jt}, \tag{4.1}$$

with

$$\varepsilon_{jt} = e_{jt}\sqrt{h_{jt}},$$

where $\{e_{jt}\}$ is a sequence of independent, identically distributed random variables with mean zero and variance 1, and h_{jt} denotes the conditional variance of interest rates for country j. Moreover, for the variance equation we use Engle's (1982) ARCH(p) model

$$h_{jt} = \omega_j + \sum_{l=1}^{q} \alpha_{jl} \varepsilon^2_{j,t-l}, \tag{4.2}$$

where α_{jl} are the ARCH parameters with $\omega_j, \alpha_{j1} > 0$ and $\alpha_{jl} \geq 0$, for $2 \leq l \leq q$.

We estimated various possible univariate AR-ARCH models for the two interest rate series, and used the optimal lag-length algorithm of the Akaike

17. The choice of the specific time series for short-term interest rates was based on data availability. Note, for example, that the 3 month T-bill interest rate for Italy was given for a shorter time interval with a time path similar to the discount rate one.

and Bayesian information criteria (AIC and BIG, respectively) to determine the order of the AR-ARCH process.[18] The two criteria select the AR(2)-ARCH(2) and AR(2)-ARCH(1) specifications for Germany and Italy respectively. Table 3 reports parameter estimates and residual diagnostics for the two models.

The insignificant Ljung-Box test statistics (10 lags) for the standardized and the squared standardized residuals suggest that the selected models explain the data fairly well. The good fit of the models is illustrated in figures 2a-2b, which plot the actual and fitted values of interest rates. Moreover, for each of the two conditional means the autoregressive parameters are highly significant statistically. The Jarque-Bera test statistic confirms the presence of normality in the German model only.

4.3. *Causal Relationships*

Following Cheung and Ng (1996), we use the cross correlations obtained from the above univariate estimations to test for causal relationships between the interest rates of the two countries. In particular, causality in the mean (variance) is examined by using the cross correlogram of standardized residuals (squared standardized residuals). Under the null hypothesis of no causality, the cross correlations at different lags are independently and normally distributed in large samples. This means that statistically insignificant cross correlations indicate the absence of a causal pattern between the series. On the other hand, significant cross correlations at any leads or lags of (squared) standardized residuals provide evidence for causality in the (variance) mean. An attractive property of the Cheung and Ng methodology is that the asymptotic distribution of the test statistic proposed does not rely on the normality of the underlying series. The reason we emphasize this feature is that in our study the interest rate model for Italy does not follow a normal distribution.

Table 4 presents the cross correlations estimated from the standardized residuals of the AR-ARCH models of table 3. The 'lag' is the number of

18. To capture any potential influence of the Maastricht Treaty on the conditional moments of the interest rates, we also included a dummy variable, dt, in our estimations (dt is equal to one for the period 1992Q1-2001Q2). According to the model selection criteria, the Maastricht Treaty has a significant effect only on the conditional volatility of the German interest rate.

quarters that the data on Germany lag behind the data on Italy. Thus a negative lag is interpreted as a lead. A lag-zero simply measures the comovement of the two series in the same quarter. A statistically significant lead (negative number of quarters) implies that the German interest rate causes the Italian interest rate. On the other hand, the significance of a lag (positive number of quarters) indicates that the interest rate in Italy causes the German one. The row labelled "mean" gives the cross correlations between the standardized residuals for Germany and Italy, whereas the row labelled "variance" gives the cross correlations between the squares of the standardized residuals. In other words, the statistics reported in the "mean" and "variance" rows test for causality in the mean and the variance, respectively. According to Table 4, the feedback effects in the means and variances involve up to a second-order lag structure and the direction of causality runs from Germany to Italy in both the level and volatility movements.

4.4. *Augmented AR-ARCH Models*

The sample cross-correlation statistics reveal useful information on the interaction between time series and on their causation patterns. This can be used to construct models that are more effective in capturing the dynamics of the data. Following Cheung and Ng (1996) we augment the original AR-GARCH models, shown in table 3, by adding the relevant and significant exogenous variables. In particular, since the evidence of causation is from Germany to Italy, we reestimate the AR(2)-ARCH(1) model for Italy by including current and lagged values of the German interest rate in the conditional mean equation, and lags of the squared German interest in the conditional variance equation.

We modify the augmented models until they pass the Q and Q^2 diagnostic tests and we use the information criteria for model selection. For the Italian interest rate the 'best' model is

$$r_{i,t} = c_i + \Phi_{i1} r_{i,t-1} + \Phi_{i2} r_{i,t-2} + \Phi_{ig,1} r_{g,t-1} + \varepsilon_{it}, \tag{4.3}$$

where $\varepsilon_{it} = e_{it}\sqrt{h_{it}}$ and

$$h_{it} = \omega_i + \alpha_{i1}\varepsilon^2_{i,t-1}, \tag{4.4}$$

In table 5 we give the maximum likelihood estimates of the above augmented model for Italy; the explanatory power of the added variable is manifested by the increase in the maximum likelihood value from -136.74 to -134.29. The estimated regression shows that the German data have a prominent impact on the mean of the Italian interest rate but there are no feedback effects in their volatility. In table 6 we present the statistics for the cross-correlations between the latter model and the German model of table 3. Observe that all cross-correlations are insignificant, unlike those given in table 4. These results indicate that the augmented ARGARCH model provides an adequate description of the dynamics and the causal relationship between the two interest rate series.

4.5. *Bivariate ARCH Models*

The estimation of univariate (augmented) AR-ARCH models can be regarded as a first step in the construction of a bivariate model for the German and Italian interest rates. On the one hand, we can use the lag structure revealed by the univariate models to select the optimal lag order of the bivariate model, and on the other hand, we can exploit the information obtained from the cross correlations to build the appropriate bivariate specification. Although we expect the causal relationships derived from the bivariate model to be similar to those uncovered by the univariate estimation, a correctly specified bivariate model will be more precise in capturing the feedback effects between the German and Italian interest rates.

We use a bivariate ARCH model to estimate simultaneously the conditional means, variances, and covariances of the two interest rates. Estimates of the German and the Italian rates are based upon the following bivariate VAR(2) model:

$$r_{i,t} = \Phi_i + \Phi_{i1} r_{i,t-1} + \Phi_{i2} r_{i,t-2} + \Phi_{ig,1} r_{g,t-1} + \Phi_{ig,2} r_{g,t-2} + \varepsilon_{i,t}, \tag{4.5}$$

$$r_{g,t} = \Phi_g + \Phi_{g1} r_{g,t-1} + \Phi_{g2} r_{g,t-2} + \varepsilon_{g,t},$$

where $r_{i,t}$ and $r_{g,t}$ denote the Italian and German interest rates respectively. We define the residual vector ε_t as $e_t = (\varepsilon_{i,t}, \varepsilon_{g,t})'$. We assume that ε_t is conditionally normal with mean vector 0 and covariance matrix H_t. That is $(\varepsilon_t | \Sigma_{t-1}) \sim N(0, H_t)$ where Σ_{t-1} is the information set up to time t-1. Following Bollerslev (1990), we impose the constant correlation ARCH(2) structure on the conditional covariance matrix H_t.

$$h_{i,t} = \omega_i + \alpha_{i1}\varepsilon^2_{i,t-1} + \alpha_{i2}\varepsilon^2_{i,t-2}, \qquad (4.6)$$

$$h_{g,t} = \omega_g + \alpha_{g1}\varepsilon^2_{g,t-1} + \alpha_{g2}\varepsilon^2_{g,t-2},$$

$$h_{gi,t} = \rho\sqrt{h_{gt}}\sqrt{h_{it}},$$

where $h_{g,t}$, $h_{i,t}$ denote the conditional variances of the German and Italian interest rates respectively, and $h_{gi,t}$ is the conditional covariance between $\varepsilon_{g,t}$ and $\varepsilon_{i,t}$. It is assumed that ω_j, $\alpha_{j1} > 0$, $\alpha_{j2} \geq 0$, for $j \in (i,g)$, and $-1 \leq \rho \leq 1$.

Bollerslev (1990) states that the constant correlation model is computationally attractive. His argument is that the correlation matrix can be concentrated out from the log-likelihood function, resulting in a reduction in the number of parameters to be optimized. Moreover, it is relatively easy to control the parameters of the conditional variance equations during the optimization so that $h_{i,t}$ is always positive.

We estimate the system of equations (4.5) and (4.6) using the Berndt et al. (1974) numerical optimization algorithm (BHHH) to obtain the maximum likelihood estimates of the parameters. Bollerslev (1990) shows that under the assumptions of our model, the BHHH estimates of the asymptotic covariance matrix of the coefficients will be consistent. Given our relatively large sample size our estimated asymptotic t-statistics should be sufficiently accurate[19].

Note that a general bivariate VAR(p) model can be written as

$$r_t = \Phi + \sum_{j=1}^{p} \Phi_j r_{t-j} + \varepsilon_t, \qquad (4.7)$$

with

$$\Phi = \begin{bmatrix} \Phi_i \\ \Phi_g \end{bmatrix}, \text{ and } \Phi_j = \begin{bmatrix} \Phi_{i,j} & \Phi_{ig,j} \\ \Phi_{gi,j} & \Phi_{g,j} \end{bmatrix},$$

where r_t is a 2×1 column vector given by $r_t = (r_{it}, r_{gt})'$, Φ is the 2×1 vector of constants and Φ_j, $j = 1, \ldots, p$, is the 2×2 matrix of parameters.

19. For completeness, we have also estimated our bivariate VAR(2)-constant correlation ARCH(2) model assuming conditionally t-distributed errors. Results from this model (not reported here) are quite similar to those reported in the text using the normal distribution

In our empirical work, we estimate several bivariate VAR specifications for the German and Italian interest rates. We used the optimal lag-length algorithm of the Akaike (AIC) and Schwarz (SIC) information criteria to determine the order of the VAR process. We estimated VAR models of order up to 4. We also estimated VAR models where the Φj matrix was either lower triangular ($\Phi_{ig,j} = 0$) or upper triangular ($\Phi_{gi,j} = 0$) or diagonal ($\Phi_{gi,j} = \Phi_{ig,j} = 0$). Both criteria chose the specifications given by (4.5). Similarly, the chosen ARCH(2) model corresponds to the smallest estimated value of both the AIC and BIC.

We have also estimated our bivariate ARCH(2) system using two alternative models of the conditional covariance matrix: first, the diagonal-vec model, introduced by Bollerslev, Engle and Wooldridge (1988), where the conditional covariance follows an ARCH(2) process:

$$h_{gi,t} = \omega_{gi} + \alpha_{gi,1}\varepsilon_{g,t-1}\varepsilon_{i,t-1} + \alpha_{gi,2}\varepsilon_{g,t-2}\varepsilon_{i,t-2}. \tag{4.8}$$

Second, there is the BEKK model, introduced by Engle and Kroner (1996). The BEKK ARCH(2) model has the following conditional covariance matrix structure:

$$H_t = \Omega\Omega' + A_1(\varepsilon_{t-1}\varepsilon'_{t-1})A_1' + A_2(\varepsilon_{t-2}\varepsilon'_{t-2})A_2', \tag{4.9}$$

with

$$\Omega = \begin{bmatrix} \omega_i \\ \omega_j \end{bmatrix}, \text{ and } A = \begin{bmatrix} \alpha_{i,j} & \alpha_{ig,j} \\ \alpha_{gi,j} & \alpha_{g,j} \end{bmatrix},$$

where Ω is the 2×1 vector of constants, and A_j, $j = 1, 2$, is the 2×2 matrix of the ARCH parameters. Note that because of the presence of a paired transposed matrix factor for each of the 2×2 matrices Ω, A_1, A_2, symmetry and non-negative definiteness of the conditional covariance matrix H_t is assured.

According to the above model selection criteria, our preferred model is the constant correlation model. Table 7 reports estimates of the bivariate constant correlation ARCH model[20]. The estimated correlation coefficient is

20. Following our univariate specifications of the previous section, we also included in the conditional variances of the bivariate model a dummy for the Mastricht Treaty. This appears highly significant in both equations.

0.19. We employed the statistic proposed by Bera and Kim (1996) to test the hypothesis of constant correlation in a bivariate GARCH model:

$$\tau = \frac{\left[\sum_{t=1}^{T} (\xi_{i,t}^2 \xi_{g,t}^2 - 1 - 2\hat{\rho}^2)\right]^2}{4T(1 + 4\hat{\rho}^2 + \hat{\rho}^4)}, \tag{4.10}$$

with

$$\xi_{i,t} = \frac{\hat{e}_{i,t} - \hat{\rho}\,\hat{e}_{g,t}}{\sqrt{1-\hat{\rho}^2}}, \quad \xi_{g,t} = \frac{\hat{e}_{g,t} - \hat{\rho}\,\hat{e}_{i,t}}{\sqrt{1-\hat{\rho}^2}},$$

where $\hat{\rho}$ is the estimated correlation coefficient, and $\hat{e}_{i,t}$, $\hat{e}_{i,t}$ are the standardized residuals for Italy and Germany, respectively. Bera and Kim (1996) showed that the above test is asymptotically distributed as a χ^2 (1). In the estimates of the bivariate model in table 7, we computed $\tau = 0.11$. This is much lower than the critical value for any conventional size of the test, so we cannot reject the null hypothesis of constant correlation.[21]

Note that the sum of the coefficients of the lagged values of the German interest rate in the Italian conditional mean is 0.05, very close to the estimate 0.06 of the causal effect derived from the univariate augmented AR-ARCH model in table 5.

5. Possible Extensions

The main goal of this paper has been to reinforce the theoretical argument of those who maintain that the causality of interest rate spillovers run from large economies to small ones rather than the other way around. In that respect the paper has achieved its goal. However, Uctum (1999) shows that the choice of interest rate, the correct modelling of long-run equilibrium conditions, and the sample period are three crucial factors in testing the GDH. His results suggest several avenues for further research.

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21. Tse (2000) proposes a Lagrange Multiplier (LM) test for the constant correlation hypothesis in a multivariate GARCH model and presents Monte Carlo results on the size and power of both the LM and the Bera and Kim (1996) tests. He reports that for the LM test there are signs of over-rejection in small samples, which are satisfactorily reduced when the sample size reaches1000. In addition, the Bera Kim test appears to have very good approximate nominal sizes.

First, most empirical studies are based on analyses of short-run interest rates and/or exchange rates and monetary aggregates. Uctum (1999) used both intervention rates and short rates to capture the monetary authorities' behavior and the markets' perception of it. He found that the Granger causality tests confirm the GDH when the analysis was conducted with intervention rates but not with short rates. We could also use intervention rates, since Uctum (1999) shows that short rates may simply give a measure of international integration of financial markets and not mimic central bank behaviour exactly.

Furthermore, our study does not examine in a trivariate context the interest rate linkages among Italy, Germany and the US but we carry out our analysis in a bivariate framework. However, Caporale and Pittis (1997) have emphasized the sensitivity of the causality inference between two variables in the case of an omitted variable. Subsequently, Hassapis et al. (1999) introduced and tested the US dominance hypothesis. They found that the US rate affects the EMS rates, both directly and indirectly, through its effects on the German rate. Uctum (1999) utilized an ECM-VAR model and conducted multivariate Granger-causality tests controlling for the cointegrating vector(s). He found that the data did not support the International asymmetry hypothesis[22] for short rates. It will be very useful to allow for the possibility that US monetary policy could affect the EMS countries. This can be done via trivariate VAR-GARCH estimates in which the US interest rate is added. This is undoubtedly a challenging yet worthwhile task.

6. Conclusion

On the basis of the evidence obtained, we could infer that for at least the two countries involved in our econometric investigation the likelihood for interest rate spillovers is evident and appears to be in accordance with our theoretical framework. In particular, while the proponents of the Stability pact would expect a two way feedback from both economies, in our case the causality appears to be running from Germany to Italy. The fact that these two countries are part of the greater EU region, where policy is geared

22. International asymmetry arises when monetary disturbances originating in the US can affect EMS countries only through their effects on Germany. Under international asymmetry, there is no causal relation between the US and the non-German EMS countries (see, Uctum, 1999).

towards a deflationary bias and within which national budgets have to be balanced, one could argue that the generated results give an indication as to the extent to which the whole rationale behind the Stability pact is sound. In addition, since the evidence points towards a one way feedback in the way interest rates interact between Germany and Italy, the argument that the economies comprising the periphery of the EU region (e.g. Greece, Portugal) might be disrupting factors for the EU's economic environment is a notion worth investigating in the foreseeable future. It is only then that insightful conclusions regarding the extent as well as the impact of the austere economic policies currently pursued in the EU might surface.

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Figure 1a: Germany
Fibor-3m (mth. avg.), 1970Q1-2001Q2

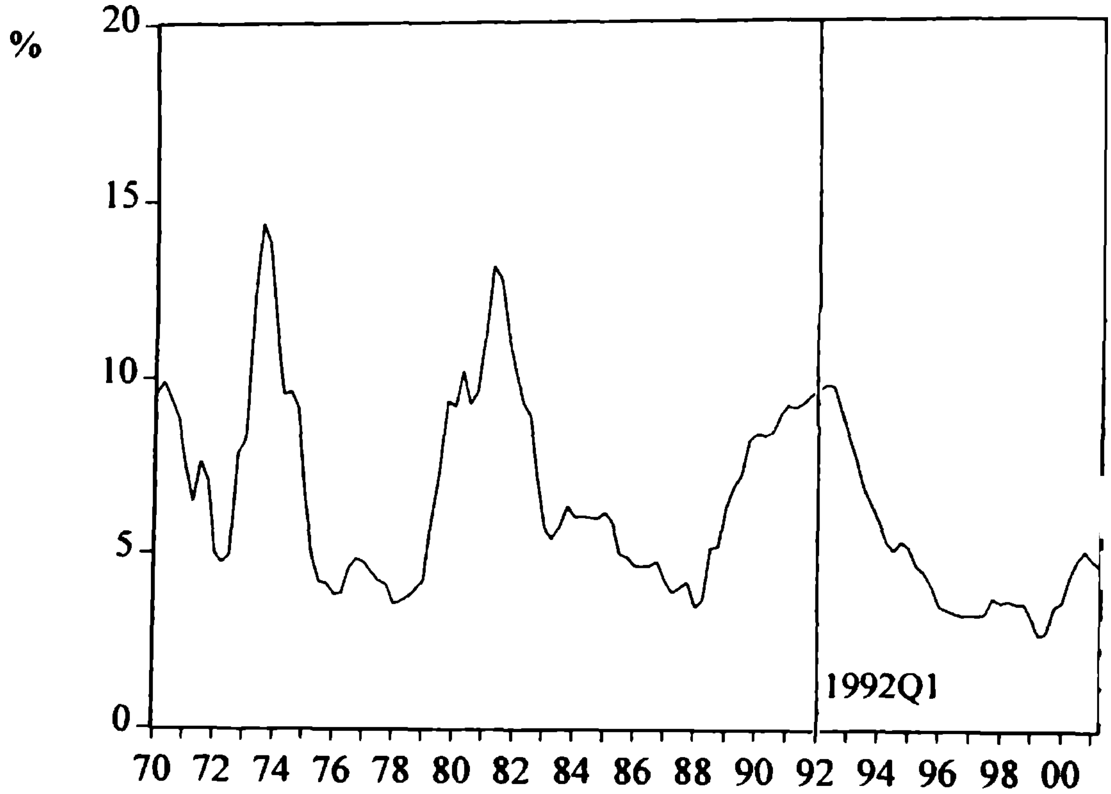

Figure 1b: Italy
Discount Rate, 1970Q1-2001Q2

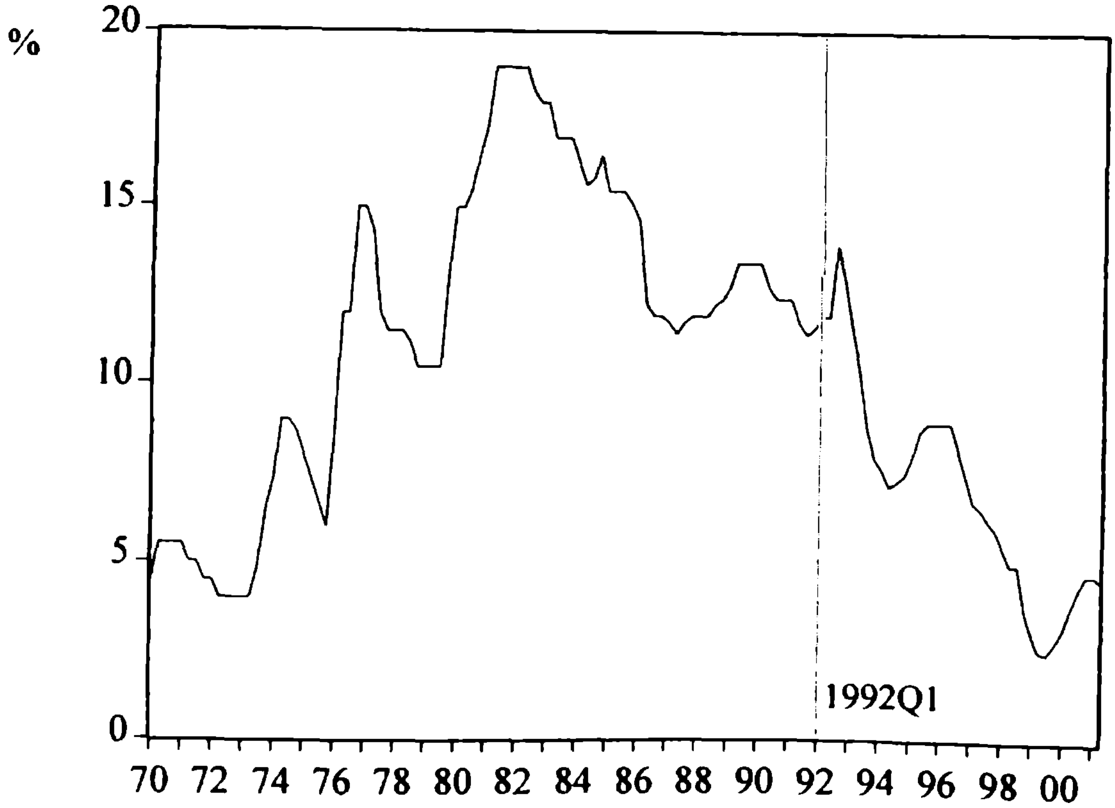

Figure 2a: Germany

Actual and Fitted values of AR(2)-ARCH(2) Model

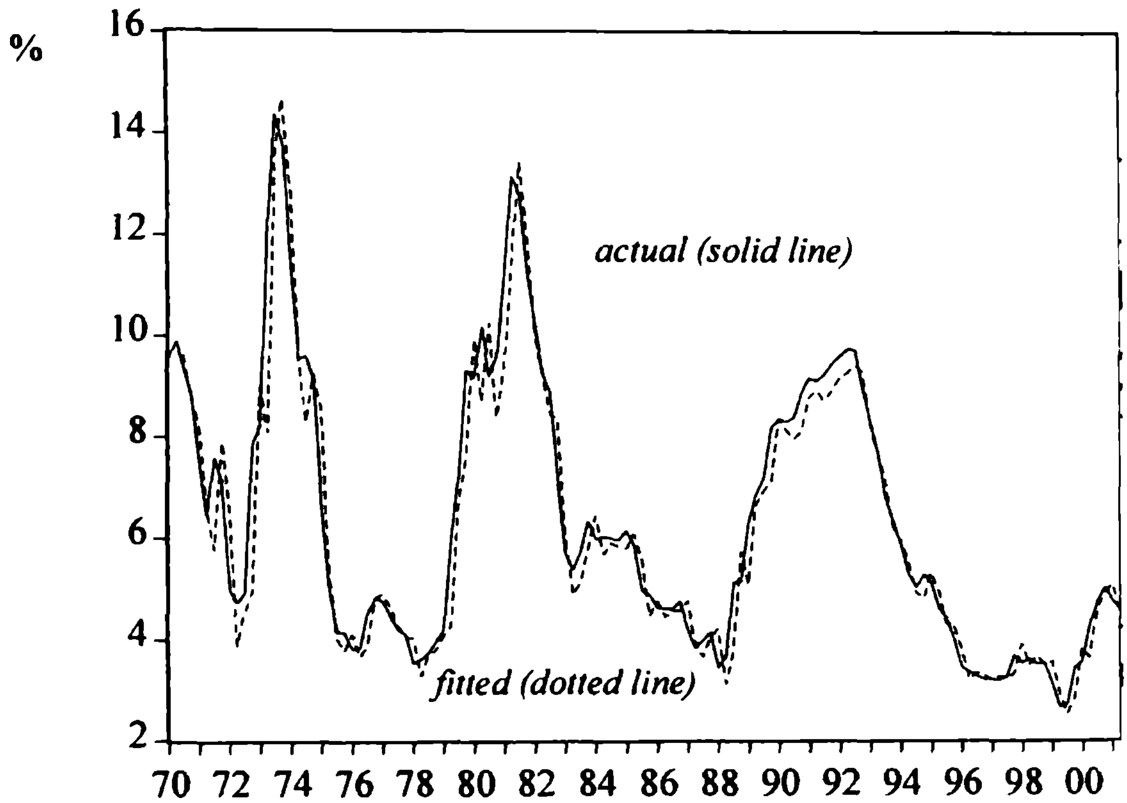

Figure 2b: Italy

Actual and Fitted values of AR(2)-ARCH(1) Model

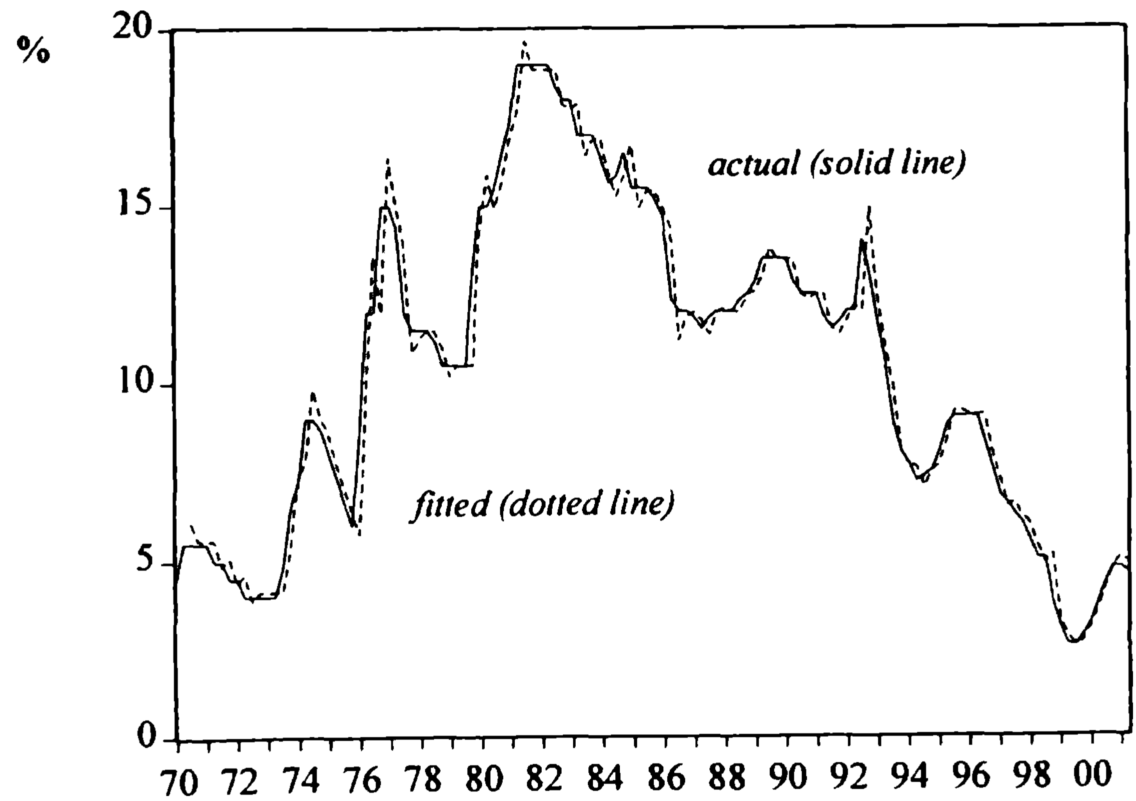

Table 1
Summary Statistics and Stationarity Tests

	Germany	Italy		Germany*	Italy
Mean	6.36	10.34	KPSS(4)	0.36	0.60
Std. dev.	2.70	4.55	KPSS(6)	0.29	0.44
JB test	13.22	5.67	KPSS(8)	0.25	0.35
	[0.00]	[0.06]			

Notes: The KPSS (k) test uses an intercept and the first k sample autocovariances.
* The null hypothesis of stationarity is not rejected at both the 1% and 5% significance levels. The critical value at the 5% level is 0.463 and 0.739 at the 1% level. *JB* is the Jarque-Bera test for normality. Probabilities are given in brackets.

Table 2
Correlograms of interest rates: $r_t = \bar{r} + \varepsilon_t$

Sample autocorrelations of $\hat{\varepsilon}_t$			Sample autocorrelations of $\hat{\varepsilon}_t^2$		
	Germany	Italy		Germany	Italy
$\hat{\rho}_1$	0.94	0.97	$\hat{\rho}_1$	0.80	0.95
$\hat{\rho}_2$	0.82	0.93	$\hat{\rho}_2$	0.44	0.88
$\hat{\rho}_3$	0.69	0.88	$\hat{\rho}_3$	0.18	0.79
$\hat{\rho}_4$	0.57	0.83	$\hat{\rho}_4$	0.06	0.69
$\hat{\rho}_5$	0.44	0.78	$\hat{\rho}_5$	-0.04	0.59
$\hat{\rho}_6$	0.32	0.73	$\hat{\rho}_6$	-0.12	0.48
$\hat{\rho}_7$	0.21	0.69	$\hat{\rho}_7$	-0.17	0.38
$\hat{\rho}_8$	0.12	0.65	$\hat{\rho}_8$	-0.18	0.27
$\hat{\rho}_9$	0.06	0.61	$\hat{\rho}_9$	-0.18	0.18
$\hat{\rho}_{10}$	0.01	0.57	$\hat{\rho}_{10}$	-0.16	0.10
Q_{10}	356	795	Q^2_{10}	132	476
	[0.00]	[0.00]		[0.00]	[0.00]

Notes: r_t and $\bar{r}$ denote the interest rate and its sample mean respectively. $\hat{\rho}_i$ is the ith sample autocorrelation. The asymptotic standard error of $\hat{\rho}_i$ is $1/\sqrt{T} = 0.09$. Q_{10} and Q^2_{10} are the Ljung-Box statistics for 10th order serial correlation in the levels and squares of the standardized residuals respectively. Probabilities are given in brackets.

Table 3

AR – ARCH estimation

Germany

$$r_t = \underset{[0.00]}{0.27} + \underset{[0.00]}{1.41} r_{t-1} - \underset{[0.00]}{0.48} r_{t-2} + \hat{\varepsilon}_t$$

$$\hat{h}_t = \underset{[0.00]}{0.28} + \underset{[0.97]}{0.004}\hat{\varepsilon}^2_{t-1} + \underset{[0.00]}{0.64}\hat{\varepsilon}^2_{t-2} - \underset{[0.00]}{0.24} d_t$$

$$Q_{10} = \underset{[0.77]}{6.48}, \quad Q^2_{10} = \underset{[0.09]}{16.38}, \quad LL = -104.65$$

Italy

$$r_t = \underset{[0.20]}{0.19} + \underset{[0.00]}{1.47} r_{t-1} - \underset{[0.00]}{0.49} r_{t-2} + \hat{\varepsilon}_t$$

$$\hat{h}_t = \underset{[0.00]}{0.42} + \underset{[0.09]}{0.31}\hat{\varepsilon}^2_{t-1}$$

$$Q_{10} = \underset{[0.74]}{7.72}, \quad Q^2_{10} = \underset{[0.62]}{8.99}, \quad LL = -136.74$$

Notes: r_t is the interest rate. $\hat{h}_t$ is the estimated conditional variance. $\hat{\varepsilon}_t$ is the residual series. The variable d_t in the conditional variance equation of Germany is equal to one for the period 1992Q1 – 2001Q2. Probabilities are given in brackets. Q_{10} and Q^2_{10} are the Ljung-Box statistics for 10th order serial respectively in the levels and squares of the standardized residuals respectively. LL is the maximum log likelihood value.

Table 4

Cross Correlation Analysis of the Causality Patern

lead/lag	-4	-3	-2	-1	0	1	2	3	4
mean	0,03	0,06	0,12	0,18*	0,12	0,05	0,07	-0,04	-0,13
variance	0,07	-0,04	0,18*	-0,04	-0,11	-0,07	-0,03	-0,08	-0,07

Notes: A lead (given by a negative parameter) means that Germany leads Italy. A lag (given by a positive parameter) means that Germany leads Italy. The row labelled "mean" gives thw cross correlations between the standardized residuals. The row labelled "variance" gives the cross correlations between the squares of the standardized residuals. The asymptonic standard error is 0,09. * Indicates significance at the 5% level.

Table 5

Augmented AR – ARCH estimation

Italy

$$r_{i,t} = \underset{[0.87]}{-0.04} + \underset{[0.00]}{1.42}r_{i,t-1} \underset{[0.00]}{-0.45}r_{i,t-2} + \underset{[0.06]}{0.06}r_{g,t} + \hat{\varepsilon}_{i,t}$$

$$\hat{h}_{i,t} = \underset{[0.00]}{0.39} + \underset{[0.09]}{0.33}\hat{\varepsilon}^2_{i,t-1}$$

$$\underset{[0.70]}{Q_{10} = 7.25}, \quad \underset{[0.31]}{Q^2_{10} = 11.60}, \quad LL = -134.29$$

Notes: $r_{i,t}$ and $r_{g,t}$ are the Italian and German interest rates respectively. h_t is the estimated conditional variance. $\hat{\varepsilon}_t$ is the residual series. Probabilities are given in brackets.Q_{10} and Q^2_{10} are the Ljung-Box statistics for 10th order serial respectively in the levels and squares of the standardized residuals respectively. LL is the maximum log likelihood value.

Table 6

Cross Correlations of Augmented Models

lead/lag	-4	-3	-2	-1	0	1	2	3	4
mean	-0,02	0,01	0,07	0,14	0,08	0,06	0,07	-0,04	-0,12
variance	0,05	-0,07	0,16	-0,05	-0,11	-0,07	-0,03	-0,09	-0,06

Notes: A lead (given by a negative parameter) means that Germany leads Italy. A lag (given by a positive parameter) means that Germany leads Italy. The row labelled "mean" gives the cross correlations between the standardized residuals. The row labelled "variance" gives the cross correlations between the squares of the standardized residuals. The asymptonic standard error is 0,09.

Table 7

Bivariate Constant Correlation ARCH

Italy

$$r_{i,t} = \underset{[0.76]}{-0.08} + \underset{[0.00]}{1.32}r_{i,t-1} \underset{[0.00]}{-0.34}r_{i,t-2} + \underset{[0.03]}{0.18}r_{g,t-1} \underset{[0.09]}{-0.13}r_{g,t-2} + \hat{\varepsilon}_{i,t}$$

$$\hat{h}_{i,t} = \underset{[0.00]}{0.48} + \underset{[0.20]}{0.19}\hat{\varepsilon}^2_{i,t-1} + \underset{[0.20]}{0.07}\hat{\varepsilon}^2_{i,t-2} \underset{[0.00]}{-0.24}d_t$$

$$Q_{12} = \underset{[0.72]}{8.75}, \quad Q^2_{12} = \underset{[0.86]}{7.02}$$

Germany

$$r_{g,t} = \underset{[0.00]}{0.27} + \underset{[0.00]}{1.39}r_{g,t-1} \underset{[0.00]}{-0.46}r_{g.t-2} + \hat{\varepsilon}_{g,t}$$

$$\hat{h}_{g,t} = \underset{[0.00]}{0.27} + \underset{[0.92]}{0.01}\hat{\varepsilon}^2_{g,t-1} + \underset{[0.00]}{0.89}\hat{\varepsilon}^2_{g,t-2} \underset{[0.00]}{- 0.23}d_t$$

$$\hat{\rho} = \underset{(0.14)}{0.19}$$

$$Q_{12} = \underset{[0.88]}{6.69}, \quad Q^2_{12} = \underset{[0.41]}{12.48}$$

Notes: $r_{i,t}$ and $r_{g,t}$ are the Italian and German interest rates respectively. $\hat{h}_{i,t}$ and $\hat{h}_{g,t}$ are the two estimated conditional variances, $\hat{\varepsilon}_{i,t}$ and $\hat{\varepsilon}_{g,t}$ are the two residual series, ρ is the estimated constant conditional correlation. The variable d_t in the conditional variance equation of Germany is equal to one for the period 1992Q1-2001Q2. Standard error is given in the parenthesis. Probabilities are given in brackets. Q_{10} and Q^2_{10} are the Ljung-Box statistics for 10th order serial correlation in the levels and squares of the standardized residuals respectively.

Abstract

The aim of this paper is to reinforce the theoretical argument of those who maintain that the causality of interest rate spillovers runs from large economies to small ones rather than the other way round. In our context such a belief stands in stark contrast to the fundamental principles of the stability and growth pact that the EU member states are instructed to adhere to. On the empirical front, a two-step procedure proposed by Cheung and Ng (1996) is employed to determine the mean and variance causal relationships. We also use a bivariate ARCH model to estimate simultaneously the conditional means, variances, and covariances of the interest rates. Germany and Italy provide the basis on which our econometric illustration is based. The results obtained are in accordance with our theoretical exposition.