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Jameel Ahmed

Sajid Chaudhry

Stefan Straetmans

2015-01

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Ahmed, Jameel* Chaudhry, Sajid M† Straetmans, Stefan‡

February 8, 2015

ABSTRACT

This paper proposes a novel approach, based on probit framework, towards measuring business cycle synchronization and financial cycle synchronization for 9 eurozone economies. We find strong cross-country synchronization in both business cycles and financial cycles. Moreover, financial synchronization dominates business cycle synchronization in the eurozone, especially after the introduction of the single currency. For some peripheral country pairs, we even find some evidence of "de-coupling" business cycles relative to the core countries but the majority of marginal business cycle effects do not change much over time. The former observation supports the often heard plea for more Europe-wide macro-prudential regulation whereas the latter observation gives ammunition to those economists that always stressed that the euro zone architecture is unfinished business and that the conditions for an optimum currency area are not fulfilled.

JEL Classification: C25, E32, F44.

1 Introduction

A reliable assessment of how synchronized different countries' business cycles are is of potential importance for policymakers: it implies they should better coordinate their monetary and fiscal policies for sake of increasing policy effectiveness (Mundell, 1961). Moreover, the current eurozone turmoil has painfully reminded us that a certain degree of cross-country business cycle

*J.Ahmed@sbp.org.pk, Monetary Policy Department, State Bank of Pakistan, Karachi, Pakistan. This author gratefully acknowledges research support from Higher Education Commission of Pakistan.

†s.m.chaudhry@swansea.ac.uk, School of Management, Swansea University, Swansea, United Kingdom

‡s.straetmans@maastrichtuniversity.nl, Limburg Institute of Financial Economics (LIFE), Maastricht University, Maastricht, The Netherlands.

synchronization is important for monetary unions to be viable in the longer-term. In other words, one may argue that the current degree of eurozone economic integration - as reflected by business cycle synchronization proxies - is too low for a viable currency union.[1] Furthermore, the wave of liberalization by eliminating restrictions on financial institutions and markets and the opening up of the flows of capital have led to a phenomenon called financial globalization.[2]

The notion of "decoupling", the opposite of cycle synchronization, has gained attention after the advent of the Global Financial Crisis (GFC). In the eurozone, the discussions of whether the idea of a common currency area was inherently flawed have regained importance.[3] Although, this notion was rejected during the early stages of the GFC, which is started in the US and spread to other countries in the world. However, the decoupling of stronger and weaker economies (stronger northern vs. weaker southern european economies) has been a topic of great interest for a few years. Therefore, we revisit this topic whether there has been more synchronization or decoupling in the eurozone.

There is no academic consensus on how to measure business and financial cycle synchronization or what the critical lower bound should be below which monetary unions are non-sustainable.[4] This paper does not focus on the latter issue but tries to contribute to the *measurement* issue of eurozone business cycle synchronization. As a benchmark for comparison, we also study the degree of financial cycle synchronization for the same eurozone country pairs. Both measures of integration should presumably have been affected by the introduction of the single currency and it is therefore interesting to investigate both concepts in parallel. Moreover, real and financial market integration are expected to be interrelated because (i) financial market fluctuations reflect the markets' expectations about future real economic activity and because (ii) cross-border trade flows require cross-border financial flows (albeit a large fraction of financial flows is admittedly not trade-related nowadays). However, we limit ourselves to making up a state of the current real and financial eurozone linkages by looking at cyclical co-movements in real and financial series

[1] Krugman and Obstfeld (2009) mentions four conditions to be fulfilled for a successful monetary union: strong intra-regional trade flows, sufficient labor mobility, similar economic structure and fiscal federalism. Since the introduction of the single currency, there has been an increase in intra-regional trade but other currency union requirements have been lagging behind. For example, labor has been largely immobile because of, e.g., legal and cultural reasons, social costs of migration etc. The eurozone crisis has also revealed structural differences between Northern and Southern countries in the eurozone. Breuss (2011) points out persistent weaknesses in competitiveness (due to, e.g., diverging cross-country unit labor costs) of some peripheral member states. As far as fiscal federalism is concerned, the eurozone does not have authority to levy taxes. Moreover, there is hardly any public support for an expansion of the current EU budget. Thus, eurozone money transfers between the nation states are relatively limited due to the limited scale of the eurozone budget. Also, the governments that have bailed out their institutions have put their home country taxpayer's interest first. In addition to these macroeconomic foundations, Swofford (2000) proposed microeconomic foundations of an optimal currency area where he questioned whether all of the members belong in the eurozone.

[2] In Europe, the integration policy started to develop with Capital Liberalization Directive of 1988, First and Second Banking Directive of 1977 and 1989 and Financial Services Action Plan of 1999.

[3] Swofford (2000) was among those who early questioned whether all members belong in the eurozone.

[4] We provide a list of papers using different methodologies to study synchronization and decoupling in Table A.1 in the Appdendix

separately. The issue of financial synchronization is also economically relevant from an investment perspective. For example, the study of financial cycles and their co-movements across assets or across borders can be a valuable tool for investors who want to rebalance their portfolios (buy and sell signals can be obtained by means of the troughs and peaks of the identified cycles; as such a framework that determines bulls and bears as well as their co-movements can be an additional toolkit for tactical asset allocation). Finally, persistent cross-border swings in financial markets can be potentially destabilizing for the eurozone and in the end also for the real economy which suggests that a proper monitoring of (increases in) financial synchronization by regulatory bodies and policymakers is desirable. Candelon et al. (2008) provide a more elaborate discussion of potential implications.

Measuring the degree of cyclical synchronization between economic or financial variables necessarily requires two steps because it demands the determination of cycle phases prior to estimating the degree of cyclical synchronization. How to determine the cycle phases in itself will not be the main focus in this paper. We rather focus on the synchronization measurement issue using the periods of sustained rises and falls reflected by the dummy phase variable as an input. We will opt for the Bry and Boschan (1971) nonparametric dating algorithm that maps original time series on binary 0/1 series that either reflect "bull and bear" periods (financial data) or "expansion and recession" periods (real output data). As a second step, we use a non-linear approach. There is no consensus in the - mainly linear - empirical synchronization literature on whether business and financial cycle synchronization has actually increased or dropped after the introduction of the euro. We wonder whether the contradictory results may be due to neglecting non-linear components in real and financial linkages and we therefore apply probit models to European real and financial cycle data. This approach allows us to see the economic impact of cyclical relations in a probabilistic way by calculating the marginal effects. Moreover, the model can be used for predicting the level used for calculating and predicting the level of cycle synchronization or decoupling. To our knowledge, the use of simple binary response models like probit or logit regressions is novel to the empirical literature on real and financial synchronization. Helbling and Bayoumi (2003) argue that joint slowdowns in economic activity actually represent structural breaks or asymmetries and are thus fundamentally non-linear in nature. We focus on bilateral real and financial linkages for 9 eurozone economies for the period from January 1960 to December 2010. We estimate a simple probit model where both left and right hand variables are monthly binary series. However, as we are focusing on the eurozone, the problem of endogeneity might also arise (Frankel and Rose, 1998). We tackle this issue by estimating the probit model via generalized method of moments (GMM), using the lagged independent variable as an instrument.[5]

Anticipating our results, we find that real and financial linkages and their corresponding marginal effects in a probit framework are mostly statistically and economically significant. More-

[5]We also estimate simple probit model via Maximum Likelihood but we do not report these results for sake of conciseness. The results are almost similar statistically and economically and available upon request.

over, probit regression outcomes suggest a stronger financial than business cycle synchronization in the eurozone. The high degree of eurozone financial synchronization provides an empirical justification for the foreseen creation of a European Banking Union. The introduction of the euro also seems to have influenced the level of business cycle synchronization over time: a few countries' business cycles de-couple from each other over the post-1999 sample but the majority of countries' business cycles gets more strongly synchronized. We believe the increased synchronization in eurozone business cycles since 1999 is in large part due to the common monetary policy pursued by the European Central Bank. More specifically, common monetary policy acts as a "common factor" in the aggregate demand of the different eurozone countries.

The rest of the paper is organized as follows. Section 2 briefly overviews the literature on synchronization and decoupling; section 3 explains the methodology used; data and empirical results are discussed in section 4 while section 5 concludes by outlining the consequences of our findings for investors and policymakers.

2 Synchronization and Decoupling

A growing body of literature already exists on cyclical synchronization and decoupling, mainly for real time series (especially business cycles) and to a lesser extent also for financial markets (the co-movement of stock market cycles). Existing studies on real and financial globalization often reach mixed conclusions on both the degree of real and financial integration/synchronization as well as on the driving forces behind it. Nowadays, because of globalization the popular assumption is that increased cross-border flows in real goods (international trade flows) and financial assets (financial capital flows) have led to an increase in both real and financial synchronization. Indeed, a lot of developing economies have put themselves on the path towards real and financial liberalization, often incentivized by large IMF support packages. As for Europe, the creation of the single market (in 1992) and the introduction of the single currency (in 1999) was also aimed at boosting intra-European trade and financial globalization. This is supposed to have led to stronger synchronization of real and financial cycles in the eurozone - an important precondition for the currency area to deliver optimal benefits to the participants of the currency union. However, the academic consensus on both presence and causes of real and financial globalization is not as strong as one would expect.

For business cycles, for example, there are both studies which support the idea of increased synchronization (Artis and Zhang, 1997,9; Artis et al., 2004; Imbs, 2004; Kose, Otrok and Whiteman, 2008) but others argue that there has been a global decoupling or regional specialization (Krugman, 1991; Krugman and Venables, 1993; Kalemli-Ozcan et al., 2001; Park and Shin, 2009; Fidrmuc and Korhonen, 2010; Kim et al., 2011; Willett et al., 2011). The latter papers argue that regions with a more specialized production structure exhibit output fluctuations that are less correlated with those of other regions with less symmetric fluctuations. Doyle and Faust (2002) and Doyle and Faust (2005) were also unable to find clear evidence of an increase in correlation of growth rates of output, consumption, or investment.

A variety of studies focused on the degree of European business cycle synchronization (De Haan et al., 2008). The picture that emerges from this literature survey is that European business cycles have gone through periods of convergence as well as divergence but that the synchronization has increased during the 1990s. The empirical evidence with regard to European financial market synchronization is also mixed. While Corhay et al. (1993), Taylor and Tonks (1989), Knif and Pynnonen (1999) and Dickinson (2000) provide support for increased financial integration, Chan et al. (1997) and Gerrits and Yuce (1999) find opposite results. Upon analyzing European equity market integration since the 1980s, Fratzscher (2002) finds that European equity markets have become more strongly integrated after 1996 (which is confirmed by Kim et al., 2005). Harding and Pagan (2006) find relatively weak evidence of business cycle synchronization but stronger evidence of financial cycle synchronization.

In this section we would like to address several questions. First, we know from the existing literature that business and financial cycles tend to co-move but the majority of preceding studies used approaches assuming that linkages are basically linear in nature. However, why would real or financial linkages be always linear in nature? In fact, it is increasingly argued in the international macro literature that the nature of cross-country dependence (either between business cycles, financial markets etc.) or crisis spillover phenomena like contagion can probably not be fully captured by linear approaches only. We therefore propose a more general approach towards identifying cyclical linkages.

Another issue concerns the temporal stability of cross-country linkages over time, i.e., do real economies as well as financial markets get more involved (integrated) through time or do we, on the contrary, observe phenomena like " de-coupling" for some country pairs? We also try to answer that question, both using the traditional linear synchronization measures as well as the probit framework. Moreover, within the context of our data set (a subset of eurozone countries), it is interesting to investigate whether the introduction of the euro represents a structural break in the linear and probit synchronization measures, i.e., whether the euro introduction has actually led to more convergence or, on the contrary, has induced de-coupling and divergence (and if so, between which countries?).

3 Methodological Framework

In this section we briefly outline the econometric methodology to identify cyclical linkages in business cycles and financial cycles. Evidently, prior to measuring cyclical synchronization, one needs to determine the cycles itself. One approach could be to use the National Bureau of Economic Research (NBER) data for business cycles in US real GDP whereas the Economic Cycle Research Institute (ECRI) also publishes business cycle dummy variables for a number of European countries. However, we will not make use of these publicly available cycle data because the ECRI database only contains part of the eurozone countries we are interested in. Moreover, we also focus on financial cycles, which are not stored in publicly available databases of renowned research institutes.

As we do not use predetermined cycle data, the question arises how to determine the real and financial cycles ourselves. Let $y_{i,t}$ denote the (log) stock price or the output series for a certain country i at time t $(i = 1, \cdots, n; t = 1, \cdots, T)$. (Financial) bulls and bears or (real) recessions and expansions are determined using the marginal transform $\varphi(\cdot)$ such that $\varphi(y_{i,t}) = S_{it}$ (for all i) where S_{it} is 1 or 0 in case of a bear (recession) or bull (expansion) period, respectively. There are two main methodological strands in the literature to select $\varphi(\cdot)$. First, Hamilton (1989) imposes a two regime Markov-switching model on $\varphi(\cdot)$ that allows for persistent upward and downward swings in $y_{i,t}$[6]. We prefer, however, a nonparametric approach which can be motivated by the complex temporal behavior of both real and financial time series and the resulting risk of model misspecification. More specifically, we opt for a popular (nonparametric) dating algorithm (Bry and Boschan, 1971)[7]. Applications of this algorithm to financial market data can found in, e.g., Edwards et al. (2003), Pagan and Sossounov (2002), Candelon et al. (2009) and Chen (2009). The algorithm recognizes time series patterns, detaches these patterns according to a sequence of rules and then locates the turning points (peaks and troughs) in the series. The employed rules, however, are typically not taken to be identical for business and financial cycle determination. Pagan and Sossounov (2002) observe that the nature of financial asset prices is sufficiently different from real quantities so that the algorithm should be implemented in slightly different ways[8]. The location of turning points amounts to identifying local maxima or minima within a window of k months. More specifically, a turning point represents a peak at time t if $y_{t-k}, ..., y_{t-1} < y_t > y_{t+1}, ..., y_{t+k}$ whereas it represents a trough if $y_{t-k}, ..., y_{t-1} > y_t < y_{t+1}, ..., y_{t+k}$. Finally, periods from peak to trough are classified as *bears* or *recessions* $(S_t = 1)$ while those from trough to peak are classified as *bulls* or *expansions* $(S_t = 0)$ [9].

After introducing an algorithm towards identifying time series cycles in the form of 0/1 variables, we are ready to perform co-movement analyses. The approach most commonly implemented

[6] See also Hamilton and Lin (1996) and Maheu and McCurdy (2000).

[7] Alternative non-parametric filters for extracting cycles that have been proposed in the literature include, inter alia, the Hodrick and Prescott (1997) filter, the band-pass filter of Baxter and King (1999) and the procedure due to Christiano and Fitzgerald (2003).

[8] Based on reviewing the literature, we implement 4 censoring criteria. First, we set a window length of six months for business cycles and eight months for financial markets. Second, we assume that a complete business cycle and a complete financial cycle cannot take longer than 15 and 16 months, respectively. Third, we impose phase durations of 6 months and 4 months for business and financial cycles, respectively. Fourth, peaks and troughs have to alternate. Finally, we choose the highest of the peaks and the lowest of the troughs in case of multiple peaks or troughs.

[9] Notice that this classic cycle definition based on peaks and troughs only makes use of the historical data of a *single* univariate time series. It follows that one only needs single country information to determine the cycles in that country variable.

towards measuring cyclical co-movement that consists of performing linear correlation analysis on business or financial cycles, see, e.g., Harding and Pagan (2006) or Candelon et al. (2009) on business cycle synchronization or Candelon et al. (2008) on financial synchronization. Although our probit approach is able to pick up both linear and non-linear synchronization, we nevertheless perform some correlation analysis as a benchmark for comparison. A probit basically enables one to calculate the probability that one country's economy gets into recession (or, alternatively, one country's stock market gets bearish) given the state of another country's economy or stock market. The relationship between the cycles of country i and j in its simplest form can be expressed as:

$$y^*_{i,t} = \alpha + \beta S_{j,t} + \varepsilon_t, \tag{1}$$

where $y^*_{i,t}$ is an unobservable variable that determines the occurrence of a recession (or, alternatively, stock market bear) at time t and $S_{j,t}$ are the time t business or financial cycle dummies of country j determined with the Bry-Boschan algorithm. However, given that we investigate the co-movement of cycles within the eurozone, this may entail possible endogeneity problems and resulting biases.

Since our interest lies with real and financial (cycle) linkages between eurozone countries, we would also like to know whether the euro introduction has had any impact on the degree of synchronization. To that aim, we define EUD as a euro dummy which is zero before the euro introduction and 1 afterwards. Next, we include an interaction term $(S_{j,t} \times EUD)$ in relation (1):

$$y^*_{i,t} = \alpha + \beta S_{j,t} + \gamma[S_{j,t} \times EUD] + \varepsilon_t, \tag{2}$$

What to expect in terms of single currency impact on business and financial synchronization? First, the introduction of the euro may have enhanced intra-industry trade across the eurozone and this in turn may have increased business cycle synchronization. Using alternative measures of synchronization than the ones we use here, Böwer and Guillemineau (2006) indeed established a positive impact of intra-industry trade on business cycle synchronization. Moreover, we believe that the creation of the European Central Bank and the introduction of a common monetary policy may be even more important for eurozone synchronization, also at the financial side. The ECB policies may effectively act as some underlying common factor in real and financial cycle co-movements.

Since $y^*_{i,t}$ is unobserved, we apply the following censoring rule to get $S_{i,t}$, the corresponding business or financial cycle variable for country i:[10].

[10]This is more of a technical artifact. The underlying cycles are either provided by standard sources, e.g., NBER,

$$S_{i,t} = \begin{cases} 1, & \text{if} \quad y^*_{i,t} > 0 \quad \text{and} \\ 0, & \text{if} \quad \text{otherwise,} \end{cases}$$

and where the unobserved variable $y^*_{i,t}$ is equal to the right hand side of equation (1)or (2). Assuming normality of the error terms (ε_t) in above relations results in a probit model, i.e.,

$$Pr(S_{i,t} = 1) = \Phi(\boldsymbol{X_t}\boldsymbol{\Theta}), \tag{3}$$

where $\boldsymbol{X_t} = [1 \quad S_{j,t} \quad (S_{j,t} \times EUD)]$, $\boldsymbol{\Theta} = (\alpha, \beta, \gamma)$ and $\Phi(.)$ is the standard normal distribution[11]. The corresponding log-likelihood is

$$\mathcal{L} = \sum_{t=1}^{T} \left(S_{i,t} \log \Phi(\boldsymbol{X_t}\boldsymbol{\Theta}) + (1 - S_{i,t}) \log[1 - \Phi(\boldsymbol{X_t}\boldsymbol{\Theta})] \right). \tag{4}$$

The estimation of parameters, $\boldsymbol{\Theta}$, is carried out via the method of maximum likelihood for the benchmark simple probit model. However, to deal with the possible endogeneity issue, we exploit the first order conditions (FOC) of (4) by noting that

$$\frac{\partial \mathcal{L}}{\partial \boldsymbol{\Theta}} = \underbrace{\frac{[S_{i,t} - \Phi(\boldsymbol{X_t}\boldsymbol{\Theta})]\phi(\boldsymbol{X_t}\boldsymbol{\Theta})}{\Phi(\boldsymbol{X_t}\boldsymbol{\Theta})[1 - \Phi(\boldsymbol{X_t}\boldsymbol{\Theta})]}}_{A} \boldsymbol{X_t} = 0. \tag{5}$$

The part labeled 'A' in (5) are the '*generalized residuals*' (Gourieroux et al., 1987) and can be exploited to form valid moment conditions for the parameter estimation under 'generalized method of moments (GMM)'.

Finally, since the Θ vector in the probit model is hard to interpret, we also report the marginal effects (MFX) of the estimates. Formally, let $\mathbf{y} = (S_{i,t})$. Differentiating (3) with respect to $\boldsymbol{X_t}$, we obtain:

$$\frac{\partial E(\mathbf{y}|\boldsymbol{X_t})}{\partial \boldsymbol{X_t}} = \phi(\boldsymbol{X_t}\Theta)\Theta, \tag{6}$$

where $\phi(.)$ is the standard normal density. The standard errors for the estimates ($\widehat{\Theta}$) and

ECRI or extracted from some reference series by a dating algorithm

[11] Assuming a logistic distribution - and thus modeling the binary linkages with the use of a logit regression - did not dramatically alter our outcomes. The outcomes remain qualitatively the same.

MFX are calculated using the robust covariance as suggested in Greene (2008). Furthermore, marginal effects for continuous variables are calculated at mean values. For the binary (dummy) variables, the MFX are computed as the change in probability when the dummy variable changes from 0 to 1.

Finally, and in contrast to the symmetry restriction $\widehat{\rho}_{ij} = \widehat{\rho}_{ji}$ for classic correlation analysis, a similar property does not hold for estimates of the coefficient vector Θ and corresponding marginal effects, i.e., $\widehat{\Theta}_{ij} \neq \widehat{\Theta}_{ji}$ [12]. Thus, it matters which cycles are selected as dependent and independent variables. However, as our empirical results will show, differences $\left(\widehat{\Theta}_{ij} - \widehat{\Theta}_{ji}\right)$ are typically small and our general conclusions on synchronization remain robust for turning around the LHS and RHS cyclical variable in the probit regression.

4 Empirical Results

4.1 Data Sources and Description

We download nominal industrial production indices (IPI) and share price indices (SPI) from the OECD database and the IFS database, respectively. We managed to gather these data for nine (9) eurozone countries on a monthly frequency between January 1960 and December 2010. The considered countries are: Austria, Belgium, Finland, France, Germany, Greece, Italy, Portugal and Spain. As a consequence, there are $C_9^2 \equiv 36$ bilateral business cycle synchronization pairs and the same number of bilateral financial cycle synchronization pairs to be considered. We estimate a (more general) probit model for this purpose. In order to keep the dimension of the reported tables manageable, we only report the bilateral results of the bigger European countries (France, Germany, Spain, Italy) with respect to each other and with respect to the smaller countries.

4.2 Estimation Results

Before we start our empirical analysis by applying the Bry-Boschan dating algorithm as well as probit model, we do univariate analysis and calculate linear correlations from raw IPI and SPI series to see what the raw data tell us about (linear) synchronization in 9 european countries. Table 1 reports the results. The table distinguishes between real and financial synchronization correlations (left vs. right panels) and full sample, pre-euro and eurozone correlations (upper, middle and lower panels). As said previously, and in order to reduce the number of correlations to be reported, we only consider the correlations for France, Germany, Spain and Italy with respect to each other as well as 5 smaller countries. Thus, the table does not contain full-fledged correlation matrices but only parts of it. A number of interesting initial observations on (linear) synchronization

[12] In general, regressing a dependent variable y on an independent variable x renders different estimates than regressing x on y and this irrespective of the type of regression (linear/non-linear) considered.

between European countries can be made from the table. First, the magnitudes of the full sample business cycle correlations are in line with previous studies (Candelon et al., 2009). Most of the full sample and pre euro sample correlations between IPI series (hereafter real cycles) and SPI series (hereafter financial cycles) are higher than 0.90. As for the magnitudes of the full sample real cycle correlations, they are marginally larger than their financial counterparts (24 out of 32 real correlations exceed their financial counterparts but the differences remain limited in most cases). The question arises how stable the correlations are over time. The introduction of the single currency in 1999 constitutes a natural sample split to consider. Upon comparing subsample correlations with each other, we observe reduction in synchronization for both real and financial after the introduction of euro in 1999. We observe "decoupling" of real cycles of Austria from France and Italy. The reduction in synchronization[13] are much larger for real cycles as compared to their financial counterparts. This univariate result support the literature on "real decoupling" or regional specialization (Krugman, 1991; Krugman and Venables, 1993; Kalemli-Ozcan et al., 2001; Park and Shin, 2009; Fidrmuc and Korhonen, 2010; Kim et al., 2011; Willett et al., 2011).

This is remarkable because co-movement indicators based on tail dependence are typically unable to detect a single currency effect on systemic risk indicators (Hartmann et al., 2006).

[Insert Table 1 about here]

Then we start our empirical analysis by applying the Bry-Boschan dating algorithm to 9 european countries' industrial production and share prices index time series. This renders turning points and resulting peak and trough phases per country. Notice the dating algorithm is applied on the series in levels (no detrending.) Tables 2 and 3 report output of the dating algorithm for the countries' business cycles and financial cycles, respectively. Each of the table's upper panel reports some basic descriptive cycle statistics like the number of economic and financial contractions, and the average duration of expansions and contractions; the tables' lower panels report the calendar dates of the peaks and troughs (in yy-mm format). The dates are grouped in blocks of five years. As a complement to the business and financial cycles dating tables, figures 1 and 2 sketch the evolution of the (log) industrial production and the (log) share price index for each of the countries together with the shaded construction periods to simplify visual cycle identification.

First, upon considering the descriptive statistics in tables 2 and 3 upper panels, one can see that the number of real contractions fluctuates between 10 (Austria) and 14 (Portugal) over the considered sample period. We observe a slightly higher cross-country variation in the number of financial contractions ranging between 6 (Greece, Portugal) and 15 (Belgium). The average duration of real and financial contractions and expansions is asymmetric in that expansions persist

[13] The reduction in synchronization can perhaps be termed as "decoupling"

longer than contractions. Also, real expansions dominate financial expansions in terms of duration. These findings confirm the preceding empirical literature (Pagan and Sossounov, 2002). Second, upon considering the calendar dates of the turning points as well as the shaded areas in the two figures, we find some casual evidence for cross-country co-movement between real and financial expansions and contractions. The dating algorithm seems able to reproduce historical recessions or stock market busts like the oil crises in the seventies, the 90-91 recession, the dotcom bubble burst and its negative real effects in the aftermath, the 9/11 terrorist attacks and their financial and real impact and last but not least the 2007 credit crisis and the resulting general economic slowdown.

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[Insert Tables 2, 3 and Figures 1, 2 about here]

Now turning to our main estimated probit results, we estimate the probit model in equation (3).

Whereas the baseline model (1) only reflects probit linkage between two countries' cycle dummies, one can augment the baseline case by including a single currency dummy (see equation 2). Finally, to address the endogeneity issue, we estimate the probit model via GMM, using the lagged RHS dummy variable as instrument(s). The empirical results are summarized in Tables 4 to 6. As in Table 1, we limit ourselves to reporting the linkages between four major EU countries (France, Spain, Germany, Italy) with respect to each other as well as 5 smaller eurozone countries. The tables report the estimated coefficients for the independent variables (cycle dummy, euro dummy) together with the corresponding marginal effects in equation (6).[14]

Estimated coefficients and corresponding marginal effects that are statistically significant at the 5 percent level are put in bold in all the tables. Moreover, we report robust standard errors beneath each estimate. Several issues will be addressed in the discussion. First, do we find statistically and economically significant probit linkages (as reflected by probit's marginal effects)? Second, are the marginal effects (magnitude, significance) robust to changing the set of explanatory variables at the RHS of the probit model? Third (and related to the previous question), what about the marginal effects' temporal stability when considering a pre-euro sample and a euro sample? Finally, do the more general linkages tell a different story about cycle linkages than the linear correlations? To answer the latter question we compare the rank orderings of the linear and probit cyclical co-movement results.

Table 4 reports full sample results on business cycle synchronization (Panel A) and financial synchronization (panel B) for the baseline model (1). The cycle dummies that are selected to be at the LHS or RHS of the probit specification (3) is to some extent an arbitrary choice. Thus, the RHS dummy variable may very well also depend on the LHS dummy variable (this is almost certainly the case for the bilateral linkages between the larger European countries that exhibit important trade linkages) and as such there may exist a potential endogeneity issue and resulting estimation bias in $\widehat{\beta}$ and the resulting marginal effects (Frankel and Rose, 1998). We remedy this endogeneity issue by resorting to GMM estimation, where we use first lag of RHS country cycle as an instrument.[15] Inclusion of first lag is intuitively and economically relevant since cycles show higher level of persistence, i.e., high (auto-)correlation at lower lags. The table reports the estimated coefficient $\widehat{\beta}$ on the explanatory cycle dummy together with the corresponding marginal effects (MFX). The economic interpretation of the marginal effects is straightforward. For example, if Spain slides into recession, the probability that Italy also ends up in recession is 67.6%. The table generally provides abundant evidence for the existence of probit cycle linkages for both the business cycle and the financial cycle pairs: both the coefficient estimates $\widehat{\beta}$ and the corresponding marginal effects are found to be statistically significant at the 5 % level for most cases. Moreover, the marginal effects are usually quite large indicating that the probit-type linkages

[14] The marginal effects for for dummies represent the change in probability of being in a recession (or bear) when the RHS dummy jumps from 0 to 1.

[15] The $J-$test for overidentifying restrictions favors one lag.

are also economically significant. The table finds the dominance of financial synchronization as compared to real synchronization (20 out of 32) that is contrary to what we observed in Table 1. There we find that the real cycles correlations were higher (marginally though) than the financial cycles synchronization. This finding is quite interesting and confirms the findings of earlier literature that the financial markets are more synchronized or integrated as compared to the real markets. One interesting observation is that the economic significance of financial cycles synchronization between our 4 major economies (i.e., France, Germany, Italy and Spain) is quite high with Greece, Italy and Portugal. This shows that over all the long run the southern european economies have been integrated.

[Insert Table 4 about here]

Next, we investigate whether GMM based probit synchronization (that is able to pick up non-linear co-movements if they exist) has been impacted by the introduction of the single currency in 1999. We do this by including an interaction term $[S_j \times EUD]$ in equations (1) and (2) where EUD is zero before January 1999 and unity afterwards. The linear subsample results in Table 1 suggest the existence of such an effect but does it persist in a probit framework that also allows for non-linearites? Results are summarized in Tables 5 and 6. The tables distinguish between business cycle synchronization (Table 5) and financial cycle synchronization (Table 6). As in previous tables, we again consider bilateral linkages of the four major countries France, Germany, Spain and Italy with respect to 9 eurozone countries (including these four). In Table 5 for the effect of the introduction of euro on the business cycles within the eurozone, we do not find any conclusive evidence for the existence of a generalized euro effect because only 12 out of 32 euro dummies are not statistically significant. Of these 12, 4 country pairs decouple (France w.r.t. Austria and Belgium; Germany w.r.t. Austria and Spain w.r.t. Belgium) and 8 country pairs get more synchronized. However, ignoring statistically significance, 6 out of 8 countries' business cycles decouple from France and 4 out of 8 countries' business cycles decouple from Germany. The findings are nevertheless different from what we find from linear correlations. There we found the decrease in the business cycles synchronization between 4 major economies and rest of the countries. However, in case of financial cycles, the euro dummy is statistically significant but for 2 cases of France w.r.t. Greece and Spain w.r.t. Italy. The results are shown in Table 6. The financial cycles of 6 out of 32 country pairs decouple. One interesting finding is that the financial cycle of Portugal invariably decouple from all the 4 major economies. Other 2 country pairs which decouple are France w.r.t. Austria and Italy. The euro dummy for rest of the country pairs show positive significant sign giving indication of increase in financial synchronization in the eurozone. Therefore, we can conclude that there is increase in financial integration (or financial cycles synchronization) in the eurozone. These results are also different from our linear correlations results where we found financial decoupling for all the country pairs except 2 (Italy vs. Greece and Spain vs. Italy). Overall, the tables do not provide strong evidence for the existence of a generalized euro effect on bilateral business cycle synchronization because the vast majority of $\widehat{\gamma}$-estimates in the business cycle synchronization regressions is insignificantly different from zero. A few country pairs nevertheless provide some evidence for "de-coupling" business cycles ($\gamma < 0$), see, e.g., the business cycle pairs involving France w.r.t. Austria and Belgium; or Germany w.r.t. Austria, and Spain w.r.t Belgium in Table 5. Stated otherwise, the divergence results support the idea of Swofford (2000) that not all member states belong in the eurozone[16]. Turning to the existence of a euro effect on financial cycle synchronization, $\widehat{\gamma}$ is found to be strongly significantly positive in the financial synchronization regressions. In other words, the introduction of the single currency coincides with a strong increase in financial synchronization between stock markets. This is in line with earlier literature (Artis, 2003; Beine and Candelon, 2011; Caporale and Spagnolo, 2011; Walti, 2011).

Overall, the European monetary union only began in 1999 and it is perhaps too early to find its long-term effects on the economies of member states, at least as far as the business cycles are concerned. However, we see signs of decoupling for some of the member states confirming the initial inflation differentials and different levels of competitiveness among member states (see Lan (2006) for detail). However, the monetary union has contributed toward more financial integration among member states. This is important for a uniform monetary policy having symmetric effects across the member states. Furthermore, this is also a prerequisite for a uniform financial system of regulation and supervision toward which the monetary union is heading after the GFC.

[Insert Tables 5 and 6 about here]

As a final empirical exercise, we assess whether the relative magnitudes of linear correlations and probit co-movements are comparable for the same country pairs. To that aim, we rank the country pairs based on simple correlations as well as on the marginal effects obtained from our probit specifications. Next, we calculate Spearman's rank correlations, r_s, between these different rankings. Results are summarized in Table 7 for the full sample, the pre-euro sample and the euro sample. As usual, the table further distinguishes between business and financial cycle results. The majority of correlations is found to be less than 1. The rank correlations after the introduction of euro is also less than 1 suggesting that the introduction of the euro does impact the co-movements between the rankings. It also implies that the results we get from linear correlations are different

[16] A theoretical story on economic divergence in monetary unions is also offered by Krugman (1991) who argues that economies of scope and scale following a monetary union can result in an increased concentration of industries whereby sector-specific shocks could become region-specific shocks and may accentuate the likelihood of asymmetric shocks leading to divergent business cycles (Kalemli-Ozcan et al., 2001).

from our non-linear approach and our proposed methodology adds value to the empirical results on business and financial cycles synchronization or decoupling.

[Insert Table 7 about here]

5 Conclusion

In this paper we propose a novel approach towards measuring business cycle synchronization and financial cycle synchronization for 9 eurozone economies. The approach is based on simple probit modeling and can pick up both linear and non-linear dependence between cycles whereas the bulk of the existing literature on business and financial cycle co-movements is linear in orientation. We assess real and financial linkages between January 1960 and December 2010. Binary cycles (0/1 variables) are identified using the nonparametric Bry-Boschan dating algorithm. Next, a probit-based framework is proposed to link different countries' real and financial cycle dummies. More specifically, the framework generates marginal probit effects that are interpretable as the increase in probability of a business cycle downturn in one country (or, alternatively, a stock market bear) given an increase in probability of a business cycle downturn (or stock market bear) in another country. We believe this type of co-movement measure for business and financial cycles has more economic content for practitioners and policymakers than the traditional correlations. Moreover, if present in the data, this approach is able to pick up non-linear cyclical behavior. To remedy the endogeneity issue, we estimate the probit model via GMM, where we use the first lag of RHS country cycle as an instrument. We also estimate simple linear synchronization measures as a benchmark for comparison.

Using the probit framework, we find strong cross-country synchronization in both business cycles and financial cycles. This is reflected by statistically and economically significant marginal effects within the probit framework. Moreover, financial synchronization dominates business cycle synchronization in the eurozone, especially after the introduction of the single currency: whereas the euro sample coincides with a strong increase in financial synchronization, business cycle synchronization does not change much. For some country pairs, we even find some evidence of "de-coupling" business cycles but the majority of marginal business cycle effects do not change much over time.

Our results suggest that monetary integration has brought more financial integration; but the impact of monetary integration on business cycle synchronization remains limited or even seems to lead to a "de-coupling" of some countries' business cycles relative to the core countries in a number of cases. The former observation supports the often heard plea for more international macro-prudential regulation whereas the latter observation gives ammunition to those economists that always stressed that the euro zone architecture is unfinished business and that the conditions for an optimum currency area are not fulfilled. Finally, the low rank correlations between cycle correlations and probit marginal effects suggest that our proposed non-linear probit framework provides different results compared to the simple correlations. Therefore, we conclude that simple probit modeling picks up both linear and non-linear dependence between cycles and adds value to the literature of business and financial cycles synchronization where the bulk of the literature is linear in orientation.

Appendix

[Insert Table A.1 about here]

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Table 1: Contemporaneous Correlations (ρ)

	Business Cycles				Financial Cycles			
	France	Germany	Italy	Spain	France	Germany	Italy	Spain
Panel A: Full sample (1960M1-2010M12)								
Austria	0.883	0.957	0.868	0.903	0.862	0.835	0.836	0.923
Belgium	0.970	0.990	0.961	0.971	0.977	0.971	0.973	0.967
Finland	0.904	0.956	0.897	0.931	0.961	0.938	0.946	0.925
France		0.963	0.987	0.990		0.983	0.987	0.963
Germany	0.963		0.949	0.951	0.938		0.972	0.943
Greece	0.981	0.931	0.966	0.972	0.942	0.917	0.929	0.880
Italy	0.987	0.949		0.976	0.946	0.987		0.941
Portugal	0.957	0.944	0.968	0.960	0.937	0.933	0.904	0.978
Spain	0.990	0.951	0.976		0.963	0.943	0.941	
Panel B: Before euro intro (1960M1-1998M12)								
Austria	0.959	0.970	0.979	0.958	0.912	0.879	0.860	0.815
Belgium	0.984	0.988	0.987	0.974	0.976	0.980	0.956	0.981
Finland	0.939	0.941	0.968	0.942	0.947	0.953	0.938	0.974
France		0.985	0.983	0.989		0.979	0.966	0.947
Germany	0.941		0.981	0.963	0.953		0.967	0.955
Greece	0.975	0.946	0.956	0.967	0.905	0.867	0.748	0.845
Italy	0.968	0.983		0.974	0.938	0.967		0.931
Portugal	0.974	0.933	0.949	0.941	0.925	0.946	0.966	0.979
Spain	0.989	0.963	0.974		0.947	0.955	0.931	
Panel C: After euro intro (1999M1-2010M12)								
Austria	-0.019	0.900	-0.147	0.110	0.498	0.420	0.391	0.910
Belgium	0.541	0.910	0.436	0.614	0.835	0.768	0.825	0.828
Finland	0.353	0.928	0.244	0.477	0.881	0.874	0.814	0.454
France		0.311	0.953	0.918		0.938	0.929	0.708
Germany	0.311		0.215	0.385	0.938		0.812	0.699
Greece	0.784	0.258	0.773	0.838	0.817	0.817	0.835	0.618
Italy	0.953	0.215		0.903	0.929	0.929		0.555
Portugal	0.777	-0.164	0.816	0.693	0.801	0.801	0.683	0.951
Spain	0.918	0.385	0.903		0.708	0.708	0.618	

This table reports contemporaneous correlations for different pairs of countries. The correlations for the full sample, the sample before euro introduction and the sample after euro introduction are reported.

Table 2: Business Cycle Dating

Year	Austria		Belgium		Finland		France		Germany		Greece		Italy		Portugal		Spain	
Stylized facts																		
# Cont.	10		12		13		11		12		11		12		14		10	
ADC	14		14		12		15		14		16		19		11		13	
ADE	43		37		33		40		34		38		29		32		42	
Peak and trough dates																		
	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T	P	T
60-65	60-12	61-8		61-1	65-6				62-8	63-2			64-1	64-8	61-3	62-4		
	65-1	65-12																
66-70	66-10	67-8	67-2	68-7		66-1	66-11	68-5	66-3	67-5	66-5	67-7			66-4	67-2		
					66-11	67-6									70-6			
71-75	74-6	75-10	74-6	75-4	74-7		74-8	75-5	73-8	75-7			71-1	72-3		71-2	74-8	75-4
													74-6	75-4	74-3	75-8		
76-80	79-12		76-10	77-9		77-3	79-8	80-11	79-12	80-9	76-11	78-1	77-1	77-11			77-4	77-11
			79-12		80-7								78-12	79-7			80-3	
													80-3					
81-85		81-6		82-3		81-6	81-12	82-8	81-10	82-11	81-8	83-5		83-5	83-6	84-4		82-8
	82-1	82-12			85-5				83-12	84-6			84-8		84-11	85-9	84-8	85-6
	83-7	84-11													90-8			
86-90	90-12		90-3			86-3	86-4	87-1			86-4	87-6		87-1			90-6	
					87-3	87-11	90-4				90-2	90-9	89-12					
					89-7													
91-95		92-12		91-7		91-6		93-6	91-1	93-7	91-9	93-7		93-7		91-4		91-3
			92-2	94-7	95-1	95-9			94-12	95-10	94-9	95-7	95-12		92-2	92-8	91-12	93-4
			95-5												94-9	95-3	94-12	
96-00	00-12			96-2	98-5	98-12	98-5	99-8	98-7	00-1	96-6	97-8		96-12	96-6	96-12		96-1
			98-7	99-2	00-10		00-12				98-3	99-4	97-12	98-12				
			00-12								00-12		00-12					
01-05		01-11		01-10		01-7		03-5	01-2	01-11		01-12		03-5	02-4	03-3	00-11	01-12
			04-7	05-3	04-12	05-6	05-1	05-10	02-8	03-9					03-9	05-5		
06-10	08-4	09-5	08-4	09-6	06-7	07-1	08-4	09-4	08-2	09-4	08-4		07-8	09-3	06-12	09-1	07-6	09-3
				08-1	09-5	10-5									10-3		10-4	

The abbreviations denote: # Cont. = No. of contractions; ADC = Average duration of contractions; ADE = Average duration of expansion; P = Peak date; T = Trough date.

Table 3: Financial Cycle Dating

Year	Austria		Belgium		Finland		France		Germany		Greece		Italy		Portugal		Spain	
Stylized facts																		
# Cont.	12		15		10		13		13		6		12		6		13	
ADC	29		18		24		16		18		22		26		20		18	
ADE	20		26		34		31		27		30		25		23		28	
Peak and trough dates																		
	P	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**	**P**	**T**
60-65	62-2		60-12	61-5	61-2	62-1	62-4	64-6	60-9	62-10			60-9	65-1			63-4	64-6
			62-11	64-2	64-3				64-9									
66-70		67-6	67-1	69-5		68-2	66-1	67-7		66-11			66-3	67-3			70-2	70-12
	67-12	69-7	70-7				70-1		69-11				67-10	68-11				
	70-9												69-11					
71-75		71-12		73-6	73-10			71-10		71-10				72-3			74-4	
	73-7	74-10	74-12	75-5			73-5	74-9	73-3	74-9			73-6					
76-80	76-4	79-2	76-11	78-5		77-10	76-2	77-4	76-3	76-10				77-12				78-2
	80-3		78-12	80-2	80-4	80-12	80-10		78-9	80-3							78-7	80-5
81-85		82-11	81-6		84-8	85-7		82-3	81-7	81-12			81-5	82-7			81-8	82-9
	83-5	84-8																
86-90	86-1	88-2		87-8	89-4		87-3	88-1	86-4	88-1	87-10	89-3	86-5	88-2	88-10	89-10	87-8	89-2
	90-3		87-12	90-1			90-5		90-7		90-7		90-6				89-9	90-9
91-95		93-1	91-1	92-5		92-9		91-1		92-9		92-11		92-9	92-11	94-3	91-5	92-9
	94-1	95-11	92-9	94-5	94-2	95-3	92-5	92-10	94-4	95-3	94-1	95-3	94-5	95-12	92-5	92-10	94-1	95-3
			95-3				94-2	95-3										
96-00	98-5			98-7	00-3		00-9		00-2		99-9		00-3			98-4	98-7	99-7
															98-10	00-3	00-2	
01-05		02-10	03-3			03-3		03-3		03-3		03-3		03-3	02-10			02-9
					04-3	04-8			04-1	04-8								
06-10	07-6	09-3		07-5	07-10	09-3	07-5	09-3	07-10	09-2	07-10	09-2	07-5	09-3		07-7	07-10	09-2
			09-3	10-4			10-4				09-10		09-10		09-3	09-10	09-12	

The abbreviations denote: # Cont. = No. of contractions; ADC = Average duration of contractions; ADE = Average duration of expansion; P = Peak date; T = Trough date

Figure 1: Dating Business Cycles. Shaded areas represent contractionary phases.

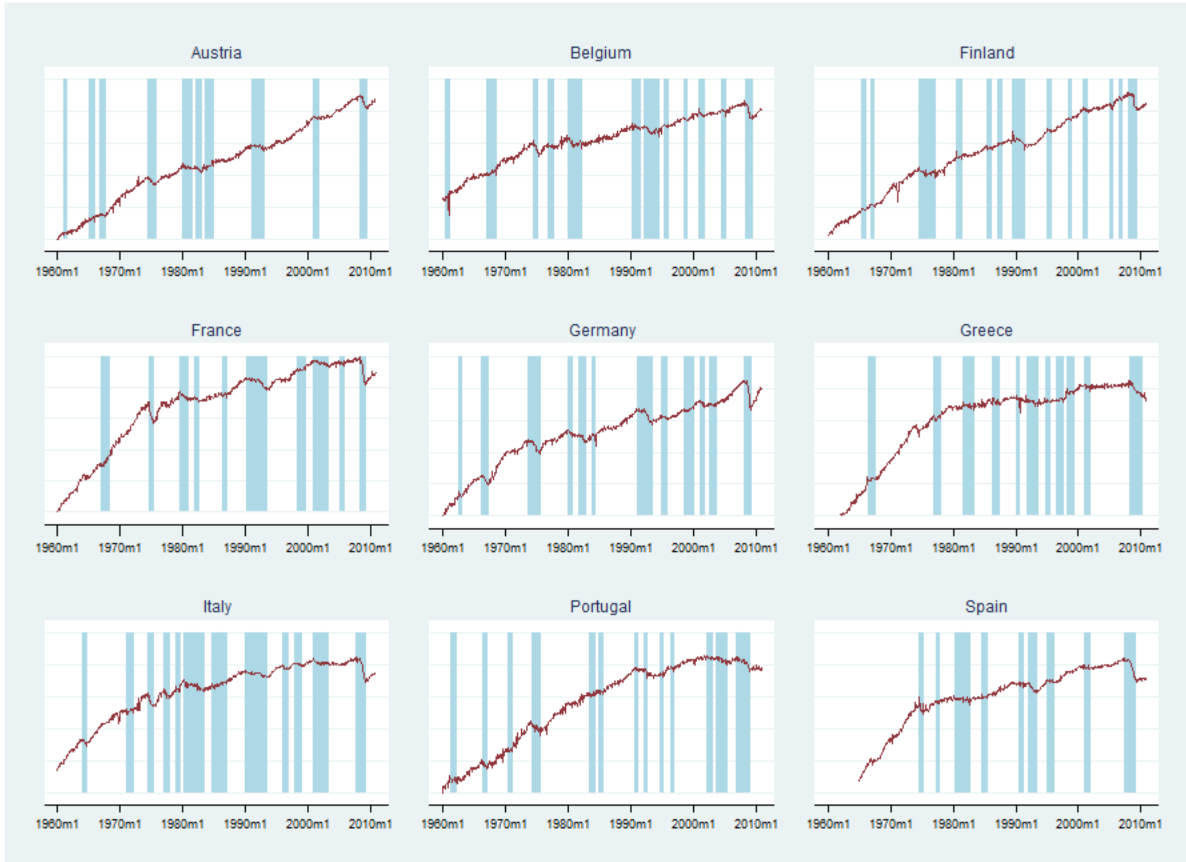

Figure 2: Dating Financial Cycles. Shaded areas represent contractionary phases

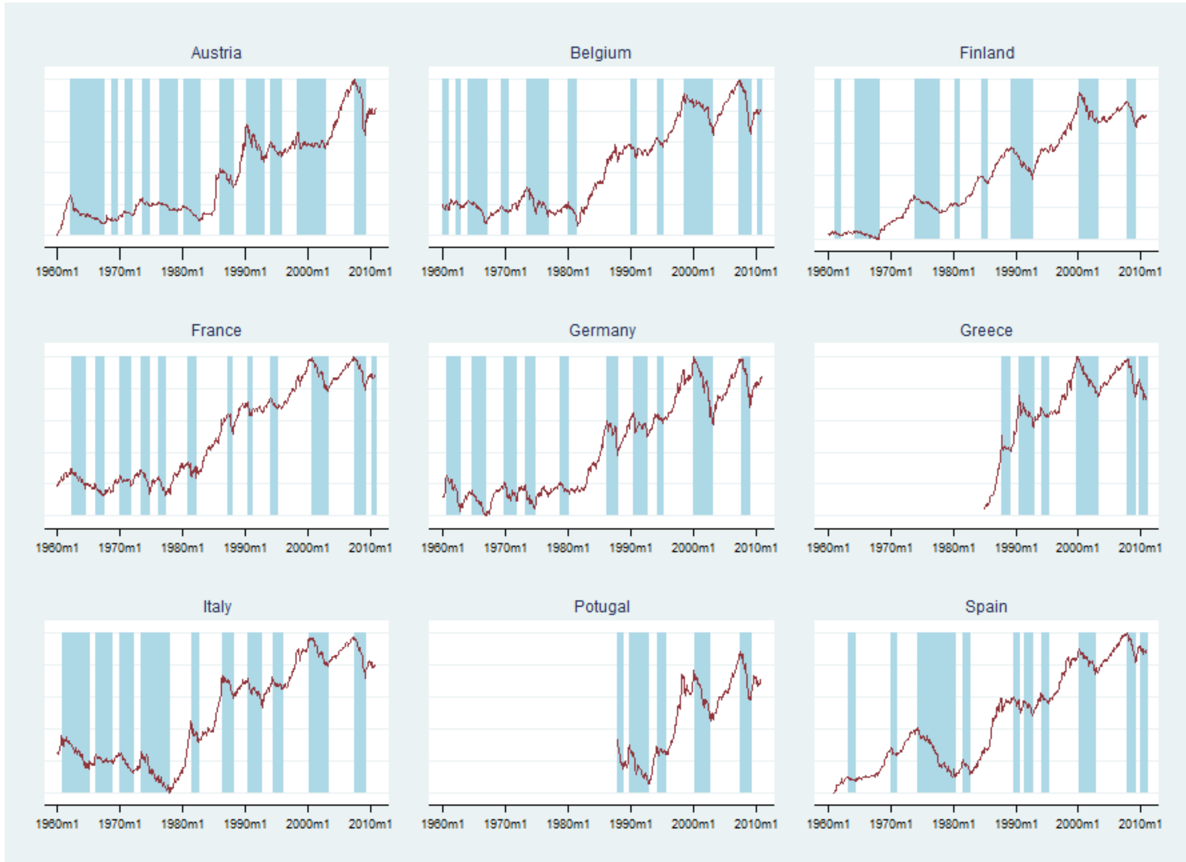

Table 4: Synchronization of Business and Financial Cycles - GMM Estimates from probit model

	France		Germany		Italy		Spain	
	$\widehat{\beta}$	MFX	$\widehat{\beta}$	MFX	$\widehat{\beta}$	MFX	$\widehat{\beta}$	MFX
	Panel A: Business Cycles							
Austria	**1.315**	**0.429**	**1.561**	**0.501**	**0.771**	**0.236**	**1.350**	**0.460**
	(0.126)	(0.042)	(0.128)	(0.041)	(0.116)	(0.037)	(0.136)	(0.047)
Belgium	**1.413**	**0.491**	**0.987**	**0.347**	**0.887**	**0.296**	**1.713**	**0.601**
	(0.124)	(0.041)	(0.120)	(0.043)	(0.113)	(0.038)	(0.141)	(0.042)
Finland	**0.585**	**0.196**	**0.460**	**0.153**	**0.485**	**0.156**	**0.818**	**0.293**
	(0.121)	(0.043)	(0.121)	(0.042)	(0.113)	(0.037)	(0.131)	(0.049)
France			**1.579**	**0.538**	**1.381**	**0.441**	**1.119**	**0.410**
			(0.127)	(0.040)	(0.119)	(0.036)	(0.132)	(0.047)
Germnay	**1.651**	**0.565**			**0.791**	**0.266**	**1.212**	**0.440**
	(0.127)	(0.039)			(0.112)	(0.038)	(0.133)	(0.047)
Greece	**0.988**	**0.351**	**0.996**	**0.354**	**1.062**	**0.355**	**0.933**	**0.344**
	(0.121)	(0.044)	(0.121)	(0.043)	(0.116)	(0.038)	(0.131)	(0.049)
Italy	**1.307**	**0.486**	**0.714**	**0.275**			**2.115**	**0.676**
	(0.124)	(0.040)	(0.117)	(0.044)			(0.168)	(0.030)
Portugal	**0.204**	0.066	**0.458**	**0.152**	**0.249**	**0.080**	**0.620**	**0.213**
	(0.123)	(0.041)	(0.121)	(0.042)	(0.113)	(0.037)	(0.133)	(0.048)
Spain	**0.946**	**0.306**	**1.083**	**0.351**	**1.674**	**0.450**		
	(0.127)	(0.043)	(0.128)	(0.043)	(0.144)	(0.036)		
	Panel B: Financial Cycles							
Austria	**1.703**	**0.560**	**1.175**	**0.429**	**1.342**	**0.496**	**0.902**	**0.338**
	(0.133)	(0.031)	(0.115)	(0.036)	(0.110)	(0.035)	(0.113)	(0.038)
Belgium	**1.195**	**0.446**	**0.890**	**0.337**	**0.624**	**0.233**	**0.803**	**0.304**
	(0.115)	(0.039)	(0.109)	(0.040)	(0.106)	(0.038)	(0.110)	(0.041)
Finland	**0.653**	**0.247**	**0.958**	**0.357**	**1.227**	**0.424**	**0.928**	**0.349**
	(0.110)	(0.042)	(0.110)	(0.039)	(0.113)	(0.035)	(0.111)	(0.040)
France			**1.110**	**0.401**	**1.670**	**0.515**	**0.918**	**0.338**
			(0.112)	(0.039)	(0.128)	(0.032)	(0.112)	(0.040)
Germnay	**1.032**	**0.386**			**1.378**	**0.467**	**0.644**	**0.244**
	(0.113)	(0.040)			(0.116)	(0.034)	(0.110)	(0.041)
Greece	**1.837**	**0.632**	**1.937**	**0.666**	**1.563**	**0.564**	**2.363**	**0.747**
	(0.188)	(0.045)	(0.177)	(0.043)	(0.161)	(0.048)	(0.204)	(0.036)
Italy	**2.168**	**0.668**	**1.632**	**0.569**			**1.009**	**0.381**
	(0.147)	(0.027)	(0.123)	(0.032)			(0.114)	(0.038)
Portugal	**1.762**	**0.615**	**2.970**	**0.828**	**2.694**	**0.820**	**2.530**	**0.791**
	(0.193)	(0.049)	(0.258)	(0.030)	(0.218)	(0.034)	(0.205)	(0.035)
Spain	**0.914**	**0.341**	**0.603**	**0.226**	**0.938**	**0.332**		
	(0.113)	(0.041)	(0.109)	(0.041)	(0.111)	(0.037)		

Notes: Probit Model - $Pr(S_{i,t} = 1) = \Phi(\alpha + \beta S_{j,t})$. S_i and S_j are business or financial cycle dummies of country i and j, respectively. The $\widehat{\beta}$ estimates alongwith its marginal effects (MFX) are reported. Robust standard errors are shown in parentheses below estimates. Bold entries show significance at 5%.

Table 5: Synchronization of Business Cycles with Euro Dummy - GMM Estimates

	$\widehat{\beta}$	MFX	$\widehat{\gamma}$	MFX	$\widehat{\beta}$	MFX	$\widehat{\gamma}$	MFX
	France				Germany			
Austria	**1.527**	**0.501**	**-0.580**	**-0.127**	**1.750**	**0.562**	**-0.607**	**-0.125**
	(0.143)	(0.047)	(0.203)	(0.035)	(0.141)	(0.043)	(0.211)	(0.033)
Belgium	**1.708**	**0.586**	**-0.758**	**-0.182**	**1.069**	**0.377**	**-0.270**	-0.080
	(0.146)	(0.045)	(0.205)	(0.037)	(0.133)	(0.047)	(0.209)	(0.056)
Finland	**0.548**	**0.183**	0.100	0.032	**0.425**	**0.140**	0.116	0.037
	(0.139)	(0.049)	(0.202)	(0.066)	(0.135)	(0.047)	(0.212)	(0.071)
France					**1.446**	**0.495**	**0.480**	**0.165**
					(0.138)	(0.046)	(0.227)	(0.085)
Germany	**1.701**	**0.580**	**-0.136**	-0.040				
	(0.145)	(0.044)	(0.206)	(0.058)				
Greece	**1.064**	**0.378**	**-0.208**	-0.064	**1.025**	**0.364**	-0.093	-0.030
	(0.139)	(0.049)	(0.201)	(0.058)	(0.134)	(0.048)	(0.209)	(0.065)
Italy	**1.385**	**0.511**	**-0.207**	-0.076	**0.653**	**0.252**	**0.204**	0.079
	(0.145)	(0.046)	(0.212)	(0.074)	(0.130)	(0.050)	(0.213)	(0.084)
Portugal	-0.004	-0.001	**0.531**	**0.187**	**0.445**	**0.148**	0.042	0.013
	(0.146)	(0.046)	(0.208)	(0.079)	(0.135)	(0.047)	(0.213)	(0.068)
Spain	**1.014**	**0.329**	**-0.191**	-0.052	**1.117**	**0.362**	**-0.109**	-0.030
	(0.144)	(0.049)	(0.203)	(0.051)	(0.141)	(0.048)	(0.211)	(0.056)

	$\widehat{\beta}$	MFX	$\widehat{\gamma}$	MFX	$\widehat{\beta}$	MFX	$\widehat{\gamma}$	MFX
	Italy				Spain			
Austria	**0.710**	**0.217**	**0.279**	0.088	**1.298**	**0.442**	**0.197**	0.060
	(0.124)	(0.039)	(0.203)	(0.069)	(0.149)	(0.052)	(0.251)	(0.082)
Belgium	**0.899**	**0.301**	-0.057	-0.018	**1.875**	**0.647**	**-0.539**	**-0.146**
	(0.120)	(0.040)	(0.202)	(0.063)	(0.159)	(0.044)	(0.256)	(0.056)
Finland	**0.414**	**0.133**	**0.317**	0.107	**0.676**	**0.240**	**0.521**	**0.190**
	(0.121)	(0.040)	(0.204)	(0.074)	(0.146)	(0.054)	(0.252)	(0.098)
France	**1.185**	**0.381**	**1.056**	**0.386**	**1.057**	**0.387**	**0.239**	0.085
	(0.126)	(0.040)	(0.233)	(0.089)	(0.145)	(0.053)	(0.253)	(0.094)
Germany	**0.645**	**0.216**	**0.678**	**0.249**	**1.195**	**0.434**	0.066	0.022
	(0.120)	(0.041)	(0.206)	(0.081)	(0.146)	(0.052)	(0.251)	(0.086)
Greece	**1.075**	**0.360**	-0.063	-0.020	**0.829**	**0.305**	**0.397**	0.147
	(0.122)	(0.040)	(0.202)	(0.063)	(0.144)	(0.054)	(0.253)	(0.099)
Italy					**2.141**	**0.681**	-0.109	-0.042
					(0.182)	(0.033)	(0.337)	(0.129)
Portugal	0.008	0.003	**0.988**	**0.364**	**0.475**	**0.160**	**0.513**	**0.181**
	(0.125)	(0.039)	(0.207)	(0.079)	(0.148)	(0.053)	(0.249)	(0.096)
Spain	**1.568**	**0.421**	**0.486**	**0.140**				
	(0.150)	(0.038)	(0.207)	(0.069)				

Notes: Probit model - ($Pr(S_{i,t} = 1) = \Phi(\alpha + \beta S_{j,t} + \gamma[S_{j,t} \times EUD])$) results. S_i and S_j are business cycle dummies of country i and j, respectively. $\hat{\beta}$ and $\hat{\gamma}$ estimates as well as marginal effects (MFX) are reported. Robust standard errors are shown in parentheses below estimates. Bold entries show significance at 5%.

Table 6: Synchronization of Financial Cycles with Euro Dummy - GMM Estimates

	$\widehat{\beta}$	MFX	$\widehat{\gamma}$	MFX	$\widehat{\beta}$	MFX	$\widehat{\gamma}$	MFX
	France				Germany			
Austria	**2.112**	**0.638**	**-0.980**	**-0.369**	**1.065**	**0.393**	**0.565**	**0.209**
	(0.170)	(0.031)	(0.076)	(0.076)	(0.123)	(0.040)	(0.086)	(0.086)
Belgium	**0.867**	**0.333**	**1.998**	**0.613**	**0.562**	0.191	**8.930**	**0.672**
	(0.125)	(0.046)	(0.408)	(0.053)	(0.118)	(0.398)	(2.272)	(0.020)
Finland	**0.376**	**0.142**	**1.001**	**0.383**	**0.652**	**0.249**	**2.168**	**0.645**
	(0.123)	(0.047)	(0.206)	(0.071)	(0.119)	(0.045)	(0.414)	(0.046)
France					**0.887**	**0.324**	**1.115**	**0.423**
					(0.120)	(0.043)	(0.236)	(0.081)
Germnay	**0.872**	**0.329**	**0.583**	**0.227**				
	(0.124)	(0.045)	(0.204)	(0.080)				
Greece	**1.583**	**0.566**	**0.418**	0.165	**1.459**	**0.276**	**8.359**	**0.648**
	(0.249)	(0.069)	(0.310)	(0.122)	(0.200)	(0.156)	(3.117)	(0.033)
Italy	**2.471**	**0.716**	**-0.752**	**-0.290**	**1.487**	**0.524**	**1.140**	**0.375**
	(0.182)	(0.027)	(0.259)	(0.091)	(0.128)	(0.036)	(0.416)	(0.090)
Portugal	**4.660**	**0.921**	**-3.211**	**-0.740**	**5.023**	**0.940**	**-2.696**	**-0.710**
	(0.448)	(0.020)	(0.454)	(0.053)	(0.472)	(0.017)	(0.495)	(0.069)
Spain	**0.675**	**0.254**	**0.882**	**0.340**	**0.278**	**0.104**	**1.543**	**0.544**
	(0.124)	(0.046)	(0.209)	(0.077)	(0.120)	(0.046)	(0.246)	(0.060)
	Italy				Spain			
Austria	**1.256**	**0.467**	**0.577**	**0.214**	**0.859**	**0.323**	**0.164**	0.064
	(0.114)	(0.037)	(0.078)	(0.078)	(0.124)	(0.043)	(0.211)	(0.081)
Belgium	**0.323**	0.120	**8.856**	**0.682**	**0.469**	**0.180**	**1.544**	**0.540**
	(0.112)	(0.251)	(12.224)	(0.020)	(0.122)	(0.047)	(0.252)	(0.059)
Finland	**1.030**	**0.365**	**1.386**	**0.506**	**0.748**	**0.283**	**0.720**	**0.280**
	(0.118)	(0.038)	(0.246)	(0.069)	(0.121)	(0.045)	(0.205)	(0.078)
France	**1.494**	**0.473**	**1.215**	**0.455**	**0.674**	**0.250**	**0.990**	**0.379**
	(0.131)	(0.035)	(0.235)	(0.082)	(0.122)	(0.045)	(0.211)	(0.076)
Germnay	**1.203**	**0.418**	**1.198**	**0.450**	**0.376**	**0.142**	**1.048**	**0.399**
	(0.120)	(0.037)	(0.235)	(0.076)	(0.121)	(0.046)	(0.209)	(0.070)
Greece	**1.223**	**0.458**	**0.900**	**0.346**	**1.850**	0.251	**8.291**	**0.626**
	(0.183)	(0.061)	(0.265)	(0.093)	(0.236)	(0.663)	(3.873)	(0.037)
Italy					**0.974**	**0.369**	**0.135**	0.054
					(0.124)	(0.042)	(0.208)	(0.082)
Portugal	**3.187**	**0.883**	**-0.762**	**-0.273**	**13.174**	**1.000**	**-10.950**	**-1.000**
	(0.317)	(0.033)	(0.351)	(0.113)	(0.388)	(0.000)	(0.398)	(0.000)
Spain	**0.776**	**0.278**	**0.936**	**0.360**				
	(0.116)	(0.039)	(0.201)	(0.073)				

Notes: Probit model - $(Pr(S_{i,t} = 1) = \Phi(\alpha + \beta S_{j,t} + \gamma[S_{j,t} \times EUD]))$ results. S_i and S_j are business cycle dummies of country i and j, respectively. $\hat{\beta}$ and $\hat{\gamma}$ estimates as well as marginal effects (MFX) are reported. Robust standard errors are shown in parentheses below estimates. Bold entries show significance at 5%.

Table 7: Spearman's Rank Correlations

GMM Estimates			
France	Germany	Italy	Spain
Panel A: Business Cycles			
0.782	0.831	0.801	0.818
0.857	0.760	0.556	0.901
0.741	0.699	0.752	0.763
Panel B: Financial Cycles			
0.734	0.771	0.755	0.739
0.684	0.724	0.766	0.599
0.661	0.882	0.815	0.676

Table A.1: Papers Using a Variety of Methodologies

Paper	**Methodology**
Artis and Zhang (1997)	Correlations between the cyclical series across countries
Fratzscher (2002)	Tri-variate VAR-GARCH(1,1)
Kalemli-Ozcan et al. (2001)	Correlation and utility-based measure of fluctuations asymmetry
Doyle and Faust (2002)	Correlation
Hallett and Piscitelli (2002)	IMF's Multimod Econometric Model
Imbs (2004)	Estimation of a system of simultaneous equation
Kalemli-Ozcan et al. (2003)	Constant Relative Risk Aversion Utility
Kose et al. (2003)	Simple correlation and dynamic unobserved factor model
Micco et al. (2003)	Gravity model of trade
Artis et al. (2004)	Markov Switching Model
Nitsch (2004)	Multivariate Logit Model
Doyle and Faust (2005)	Rolling correlations
Mann-Quirici (2005)	Vector Autoregressive Model
Lane and Walti (2006)	Correlation
Alesina et al. (2008)	GLS regression
Kose, Otrok and Whiteman (2008)	Bayesian dynamic latent factor model
Kose, Otrok and Prasad (2008)	Dynamic factor model
Kenourgios et al. (2009)	Asymmetric Generalized Dynamic Conditional Correlation
Park and Shin (2009)	Cyclical measure of output for the three blocs
Walit (2009)	Concordance measure
Fidrmuc and Korhonen (2010)	Dynamic correlations
Caporale and Spagnolo (2011)	Tri-variate VAR-GARCH(1,1)
He and Liao (2011)	Multi-level structural factor model
Kim et al. (2011)	Panel VAR
Willett et al. (2011)	Correlations of GDP growth and deviation from GDP growth trend
Jimenez-Rodriguez et al. (2013)	Markov Switching Model and concordance indices