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# The More the Merrier? The Reaction of Euro Area Stock Markets to New Members

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## Abstract

The adoption of the euro is a crucial turning point for the economy of any EU member and the culmination of a long process of exchange rate management and macroeconomic convergence. But how does the prospect of euro area enlargement play out in the countries that have already adopted the euro? Are new members seen as a way to expand the club of like-minded countries, or are they perceived as a threat to stability, either because there exists a moral hazard risk from the side of old members to adopt riskier behavior on behalf of new members or vice versa? This paper looks at the effects of the news of the euro's adoption event in new members on the stock returns of nineteen euro area countries, employing both an event study methodology and APARCH modeling to capture and test the form of responses of European financial market volatility. Our results show that markets were indeed pleased when new members joined the euro area, with negative responses due solely to local conditions rather than euro area-wide travails. In our most interesting finding, the expansion of the euro actually helped to dampen local market volatility in the post-crisis period in the founding member states, while euro adoption quelled volatility both pre- and post-crisis for non-founding members.

**Keywords:** *euro, currency union, asymmetric effects, event study, APARCH, volatility*

**JEL Codes:** G15, F36, F33

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## 1. Introduction

The introduction of the euro is the biggest step that a European Union Member State can take towards economic integration with its fellow members. The benefits of euro accession and why a country would wish to accede have been well-explored in the literature, including the lowering of transaction costs due to a common currency (Hurnik *et al.* 2010), a reality which should improve overall firm performance (especially for exporters). Involvement in the single currency should also help to increase competitiveness through price transparency (Ottaviano *et al.* 2009), while the euro's presence should help to drive macroeconomic convergence and reduce the "volatility of macroeconomic fundamentals of the historically unstable European economies" (Morana and Beltratti 2002:2048). Additionally, other authors have conjectured that the euro would improve allocative efficiency and provide more space for risk-sharing (Sørensen and Yosha 1998). Finally, as stock returns in a currency union should be dependent on expectations regarding future returns, interest rates, and risk premiums (Baekert *et al.* 2013), euro adoption should also presumably feed into lower stock volatility (Kim *et al.* 2005).

These positive effects have been mooted almost solely for the country, which is acceding to the euro area (EA), however, leaving little evidence on how existing members would view the expansion of the single currency zone. This is an important point, as the incentives of existing euro area members are to jealously guard the macroeconomic stability of the union and not allow new members who may upset that balance. Put another way, with monetary policy being outsourced and if the benefits of the euro include lowered transaction costs and dampened volatility, there is a massive incentive to only admit members who will continue these conditions.

Unfortunately, as the events in Greece from 2009 onward has shown, there is a measure of asymmetric information regarding those joining the euro area, as it is not always easy to distinguish who will help maintain stability and who will not. In such a situation European capital markets, and especially those in existing euro area states, have a role to play in transmitting information on the desirability of the next addition to the currency area.

The valuable nature of this informational effect can be attributed to the fact that the actual introduction of the euro is the last step in a long journey of legislative and economic alignment with existing euro members, a journey beginning with behind-the-scenes negotiations and continuing through a public announcement of a country's planned accession and internal political debates approving the move (Pechova 2012). As this process continues, markets may express their judgments via volatility effects and negative returns surrounding both the announcement of a new member and the actual accession of that country to the currency union. Moreover, these judgments may not be static but rather conditional on the timing of the introduction of the currency. In

particular, prevailing economic conditions in EA countries could have a sizeable impact on EA stock markets, with favorable economic conditions likely to induce markets to see additional euro area countries more positively and poor conditions (i.e. a financial crisis) creating much more uncertainty.

Despite this firm theoretical grounding, there is a noticeable gap regarding the effects of the introduction of the euro on existing Member State financial markets in the extant literature, with most work focusing on financial convergence and linkages after the euro has been adopted (Bartram *et al.* 2007; Alexandrou *et al.* 2011). This omission is puzzling, as the macroeconomic “news effect” on stock returns and volatility has been extensively explored; indeed, this prior research provides a solid foundation for theorizing on the possible effects of reactions to the expansion of the euro area.

The purpose of this paper is thus to examine the effects on capital markets of euro accession, taking up the challenge of Green and Bai (2008:445) for “more detailed research on capital market impacts of the new currency” and filling the euro area-sized hole in the literature. Using event study methodology and asymmetric power-ARCH (APARCH) modeling, we explore if the adoption of the euro in new countries harmed or helped stock markets throughout the EA, conditional on the country which was joining. Second, we also analyze if the timing of the euro adoption, also conditioned on the size of the country but in addition, the general macroeconomic environment, mattered for the direction or magnitude of this effect.

Our results show that markets were indeed pleased when new members joined the euro area, with negative responses due solely to local conditions rather than euro area-wide travails. In our most interesting finding, the expansion of the euro actually helped to dampen local market volatility in the post-crisis period in the founding member states, while euro adoption quelled volatility both pre- and post-crisis for non-founding members. Despite heterogeneity in responses, this result is robust to several behavioral and macroeconomic controls.

The rest of the paper is organized as follows: Section 2 explicitly formulates our research hypotheses in the context of the extant literature, while Section 3 describes the data and lays out an estimation strategy. Section 4 provides results and a discussion and Section 5 then concludes.

## **2. Euro Adoption and Responses to Joining the Club**

As noted, the effects of euro adoption on the stock markets of both acceding and existing euro area countries have not been explicitly detailed in the literature. Only two notable exceptions stand out, with Green and Bai (2008) and Morana and Beltratti (2002) examining respectively the effects of the euro on stock market returns and volatility. Green and Bai’s (2008) work utilized event study

methodology to capture the effects of euro adoption at its inception in January 1999 on EA stock markets. Considering the euro adoption as a market reform rather than a completely anticipated event, they report significant cumulative abnormal returns in both euro and non-euro European stock markets after the euro was introduced in all founding Member States. Interestingly, Green and Bai (2008) do not look at market volatility after the euro was actually adopted, a key theme which was explored instead in Morana and Beltratti (2002); exploring the changes in market volatility in France, Germany, Spain, Italy, the UK and the US following the euro introduction event, Morana and Beltratti found a brief burst of volatility but a longer-term significant reduction in volatility in the Italian and Spanish stock markets.

With these papers the only previous empirical evidence on the effects of euro accession on capital markets, we must look elsewhere in order to tackle the question of how existing euro area markets react to news of new members. Indeed, our approach is to infer these effects from clues spread across three separate research strands in finance and economics: first, news effects and the linkages between capital market movement and macroeconomic news (as typified in papers such as Mitchell and Mulherin [1994] and Hayo and Kutan [2005]); second, spillover effects across capital markets (as shown in a European context in recent work from Fedorova and Saleem [2012] and Caporale *et al.* [2016]); and finally, asymmetric responses to particular news items, conditioned on the type of news and the source (Veronesi [1999] or Boyd *et al.* [2005]). Amassing the lessons from this research, we have fashioned three hypotheses regarding how the adoption of the euro would impact both new and existing members.

*H1: News of or the actual introduction of the euro has a beneficial effect on the returns and volatility of the stock market in the country which introduces the euro.*

Fundamentally, under the assumptions of efficient markets and identically-informed investors behaving rationally, stock prices should depend on expected cash flows, the discount rate, and stock- or market-specific risk premia. This hypothesis takes this reality into account, theorizing that effects of joining the euro imply a rational response by financial markets to possible changes in the long-term value of the currency, lower inflation volatility (Mongelli and Wyplosz 2008), greater earnings potential due to access to larger markets (Badinger and Breuss 2009), and lower transaction costs (Hurnik *et al.* 2010). Moreover, the adoption of the euro may significantly change the business environment of the countries acceding to the common currency, making them more open for foreign investment; for smaller countries especially, acceding to the EA could have major benefits in terms of access to capital and help to dampen financial volatility via financial depth (Agénor 2003). On the

other hand, euro adoption may also increase exposure to other euro area markets, leading to an increase in volatility beyond that generated by domestic events (Billio and Pelizzon 2003).

We assume for this paper that the news of euro adoption should be greeted warmly by financial markets within the acceding country, leading to higher returns at both the announcement of the euro's adoption and (lesser) at the actual adoption of the euro. Given the long lead-in process to euro adoption, it is anticipated that markets will price in the benefits of the euro before its introduction, but that the actual step in joining the club will occasion some abnormal returns for a time. In line with Morana and Beltratti (2002), we also assume that euro adoption will have a longer-term dampening effect on financial markets in the home country, mainly through a lowering of transaction costs (Hau 2006) and convergence in financial development (Kim *et al.* 2005).

*H2: The effect of news or introduction of the euro within a country was different pre-global financial crisis and post-crisis.*

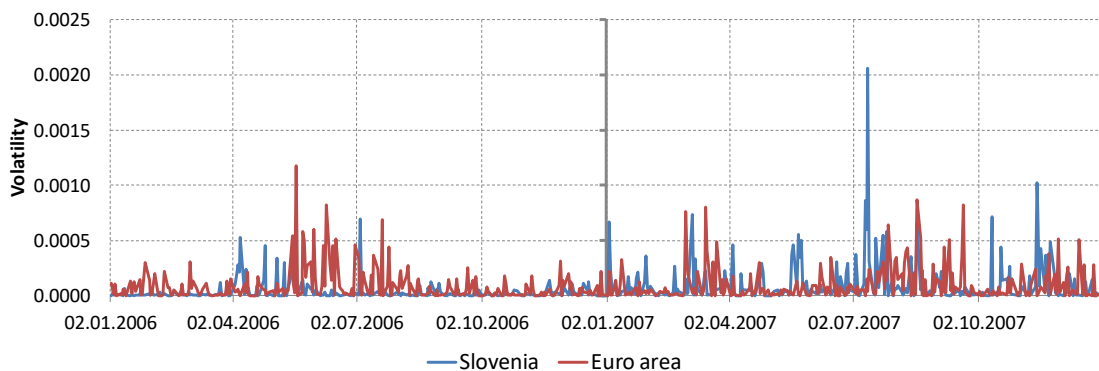
The linkage between extant economic conditions and the stock market has a long pedigree in financial economics, going back to Chen *et al.* (1986) and further advanced by Cutler *et al.* (1989) and McQueen and Roley (1993). McQueen and Roley's insights are the asymmetry of market responses to different types of news and how these responses are dependent upon the overall economic environment. In particular, the authors concluded that good news related to real economic activity is generally damaging the stock market returns if overall economic conditions are already good. To put it another way, unanticipated hikes in economic activity in a weak economy may raise expectations about future economic activity and cash flows, but the same information in a strong economy does not necessarily lead to higher expected cash flows.

Veronesi (1999) formalized this response in a model which explicitly allowed variation in investor responses to dividend news in different states of the economy. If the tone of the macroeconomic news goes against current market directions, it generates a high level of investor uncertainty about the state of the market and its future direction, leading investors to discount the new information at a higher rate. However, this model also assumes a measure of asymmetry, as investors overreact to bad news in good times and underreact to good news in bad times. In good times, bad news produces high stock price volatility and higher uncertainty about a firm's fundamentals, causing stock prices to fall further than the reduction in expected future returns that news may bring (overreaction). Whilst good news in bad times also produces a higher level of investor uncertainty on future cash flows (reflected in increased volatility of stock prices), dampening any upward adjustment in stock price and keeping such adjustments lower than the increase in

expected cash flows (underreaction). This model is in line with psychological assessments of how people filter good and bad news differently (Baumeister *et al.* 2001).

Veronesi's (1999) model has stood up well to empirical tests, with confirmation of his thesis to be found in the work of Flannery and Protopapadakis (2002), Adams *et al.* (2004), and Boyd *et al.* (2005), in relation to the news on unemployment. Minor exceptions to this consensus exist: Docking and Koch (2005), in their investigation on the sensitivity of US investors' reactions to dividend announcements under different market conditions, found that the congruence of recent market direction and volatility were statistically and economically significant for bad news in good markets, but not for good news (i.e. there was no evidence of underreaction, only overreaction). Similarly, Andersen *et al.* (2007) explore asset price responses to the fundamental economic news in the U.S., German and British stock, bond and foreign exchange markets, finding symmetrical responses to bad news during expansions and good news in recessions. Brenner *et al.* (2009) also find that positive surprises have a stronger impact on stock returns than negative surprises in the US market. However, despite these findings, more recent work by Knif *et al.* (2008) in regard to inflationary news, Birz and Lott (2011) in regard to both GDP and unemployment news, and Garcia (2013) on all types of financial news during a recession have also confirmed the underlying precepts of the Veronesi (1999) model.

**Figure 1:** Stock Market Volatility in Slovenia and the euro area, 2006–2007

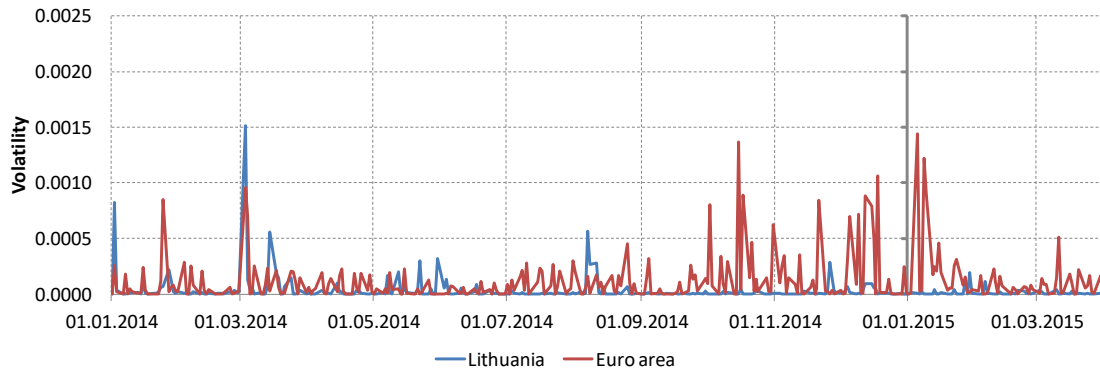


*Note:* Volatility is calculated as squared log daily returns. Authors calculations based on Bloomberg data.

In the euro area, it is anticipated that market reactions to new euro entrants followed a similar pattern as Veronesi's model, with the break-point being the global financial crisis. A look at the data from the comparative experiences of Slovenia and Lithuania could help to illustrate these effects. Slovenia adopted the euro in 2007 (pre-crisis) to broad popular support within the country, with more than a third of Slovenian businesses expecting positive results (Eurobarometer 2007). The Slovenian stock market was also welcoming, with low levels of volatility throughout 2006 in tandem

with generally placid EA stock markets (Figure 1). Removing a spike in volatility six months after the adoption of the euro due to the country’s presidential elections, the remaining movement in the volatility of Slovenian log stock market returns closely follows movements in their new EA counterparts.

**Figure 2:** Stock Market Volatility in Lithuania and the euro area, 2014–2015



*Note:* Volatility is calculated as squared log daily returns. Authors calculations based on Bloomberg data

On the other hand, Lithuania joined the EA in 2015, immediately following a period of incredible turmoil surrounding Greece and its possible exit from the EA. Moreover, during the run-up to the introduction of the euro, the Lithuanian public was considerably wary of the changeover, with only 44% of respondents in a poll believing that the Euro would have positive consequences for the country (Eurobarometer 2015). But while the Lithuanian stock market was incredibly calm when the euro was actually introduced (Figure 2), the euro area exhibited high spikes in volatility around this event (with the largest jump in over a year seen immediately following the euro’s adoption). While other major macroeconomic news was occurring around the same time (in particular the Greek elections on January 25 and the initiation of the ECB’s own version of quantitative easing), they were also related directly to the expansion of the euro area; such increased volatility was thus perhaps signaling that markets were not so sanguine about adding another, poorer country to the mix at a time of already-heightened uncertainty.<sup>1</sup> Additionally, the time to joining the euro from the announcement of joining in Lithuania’s case was one of the shortest on record (July 23, 2014 to January 1, 2015), meaning that euro area markets may not have had time to process the information.

Beyond this eyeballing of the data regarding two separate euro accession countries, there is also some econometric evidence to show state-dependence in how news is absorbed in the euro area. For

<sup>1</sup> Indeed, the Greek election campaign was fought entirely on the question of a bailout from the EU and resulted in a victory for the anti-bailout forces. See Koliastasis (2015) for further details.



example, Fernández-Rodríguez *et al.* (2015), looking at transmission of volatility through the sovereign bond market of EA states, found that the peripheral EA countries (Italy, Spain, Portugal, and Ireland) triggered volatility spillovers throughout the EA but only after the global financial crisis (“core” EA countries were the source of spillovers before the crisis). Similarly, Koulakiotis *et al.* (2016) also find strong volatility and error spillovers amongst the banking sectors in Germany, Greece, Ireland, Italy, and Spain in regard to bad news emanating from Greece; more importantly, their findings were also contingent on the state of the economy, with volatility remaining more persistent and widespread after the Greek crisis than before. Given these results, we believe that the market response to euro adoption across the EA will be conditional not only on the country entering but on when a country enters as well.

*H3: Adoption of the euro by another country will have an asymmetric impact on the local stock market of existing euro members, dependent on which country is joining.*

Finally, Hypotheses 1 and 2 should be uncontroversial, given the large body of literature surrounding currency unions and positive macroeconomic news. But in tandem with the domestic effect of euro introduction, as we note above, there also should be effects occurring in the capital markets of countries which are integrated economically and financially with the country introducing the euro. Such effects have been explored in a sizeable and varied literature on the volatility spillover effects of macroeconomic news across large and integrated markets. Engle *et al.* (1990) note that spillovers can be thought of as “heat waves” or “meteor showers:” under the “heat wave” hypothesis, higher volatility is seen as a local phenomenon, which does not spread from market to market in any sequential fashion, but a “meteor shower” would see higher volatility spills from one market to the next over the course of the global trading day. The evidence presented by Engle *et al.* (1990) is that volatility spillovers tend to follow the “meteor shower” path, a result which has been replicated several times: for example, Connolly and Wang (1998) argue that macroeconomic news has little *return* spillover effect across the US, the UK, and Japan, but does have a significant effect on *volatility* spillovers across the three countries. In particular, they find that foreign news has a stronger impact on the volatility of the local market than local news. Nikkinen and Sahlström (2004) also find that US domestic announcements (employment reports) have a larger effect on European markets than in the US. More recently, Jiang *et al.* (2012), considering the effects of European news on US stock markets and vice versa, find comparable results, although they make a distinction regarding the volatility engendered by unscheduled announcements, which tends to be much higher than volatility

accompanying scheduled announcements.<sup>2</sup> Similarly, Kim *et al.* (2015) discovered that bad news in the euro area increases volatility in the US and China, while bad news from the US had a paradoxically calming effect on euro area stock markets after the global financial crisis.

Similar to the voluminous literature on spillover effects, there is a well-developed literature on asymmetric effects of news, with bad news assumed to have a much stronger effect on stock market returns and volatility than good news. There has been a veritable torrent of work confirming the volatility-creating effects of macroeconomic news in the past decade, with papers such as Nikkinen *et al.* (2006), Brenner *et al.* (2009), and Rangel (2011) showing how bad news tends to generate more volatility (in addition to poor returns) than good news, dependent upon country-specific traits. Moreover, the content of the news also has its own magnifying effect on responses: for example, Bomfim (2003) shows that if an announcement contains new information previously not incorporated in stock prices, the volatility of stock markets tends to increase in the short-run.

In each of these cases, however, the volatility transmission of news occurred either within or across countries that had independent monetary policies, currencies, and financial markets. What of the case where monetary policies are integrated into a common currency, even though financial markets remain independent, as in the euro area? Kohonen (2013), echoing Connolly and Wang (1998), found that local macroeconomic news may be digested more accurately by local investors, but overlapping stock markets such as in the EA can help to increase the number of uninformed investors, thus exacerbating volatility and spillover in a crisis. Bhanot *et al.* (2014) provide further empirical evidence, finding that negative news announcements regarding the Greek crisis have had significant spillover effects in other EA countries, with the Netherlands, Spain, and Portugal seeing substantial increases in financial volatility.

This wealth of research begs the question, however, is either the introduction of the euro or its expansion good news or bad news? Our conjectured answer to this question is *it depends*, mainly on which country is joining. Our hypothesis here asserts that spillover effects, coinciding with news events, should be highly country-dependent (and thus asymmetric), as a country with perceived excellent macroeconomic fundamentals and stability is likely to be welcomed by financial markets of existing euro Member States, while unstable or “bad” candidates could generate higher levels of financial volatility. Markets already do a fairly good job of differentiating amongst the EA Member States in regard to their relative risk (Ribeiro *et al.* 2017), so it is plausible to assume that acceding EA members would also be under the same scrutiny by stock markets. We thus anticipate that a host

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<sup>2</sup> Their results are in line with an *ex ante* updating of expectations by market participants as the reaction to the anticipated shocks, while unanticipated news implies overreactions reflected in volatility hikes.

of country characteristics (explained in greater detail below) would help markets to make such a judgment.

While our paper would be the first to explicitly model this relationship in the euro area, there are some studies which appear to offer some empirical hints of the existence of this relationship already. Fratzscher (2002) noted that financial convergence (measured by volatility of exchange rates) in the euro area was driven by the removal of uncertainty regarding monetary unification; if this is the case, the converse is likely to be true, i.e. that increased uncertainty regarding the next steps in the monetary union would lead to higher volatility. More recent work from Caporale *et al.* (2016) also confirms asymmetrical responses to bad news during the euro area crisis, but also note that the responses were stronger in the PIIGS countries (Portugal, Ireland, Iceland, Greece, and Spain) both during and after the global financial crisis; already at the lower-end of the euro area in terms of GDP and financial stability, the introduction of even-poorer countries to the EA after the crisis may have colored the perceptions of these markets unfavorably.

### 3. Methodology and Data

#### *Hypothesis H1*

The hypotheses noted above require different approaches in order to explore the effects of euro introduction on stock markets in Europe. For Hypothesis H1, relating the introduction of the euro to changes in returns in the domestic stock market, we use an event study approach in the vein of Green and Bai (2008). The use of event studies is common in the finance literature to assess the impact of particular pieces of news on financial markets, and the adoption of the euro can be considered as a highly significant news event; indeed, euro introduction has the potential to lead to significant changes in the business and economic environment of the introducing country and can alter capital markets, firm strategies, and firm valuation.

Our event study follows an event dummy approach, pioneered by Karafiath (1988):

$$R'_{i,t} = \mu_i + w \cdot M'_t + \sum_{j=T-u}^{T+v} \beta_{i,j} D_{j,t} + \varepsilon_{i,t}. \quad (1)$$

Raw data on daily stock indices ( $P_{i,t}$  in country  $i$  on trading day  $t$ ) in 19-euro area countries is sourced from the Bloomberg database over the period January 1, 1996 to May 18, 2015, and transformed into logarithmic returns by:  $R_{i,t} = \ln P_{i,t} - \ln P_{i,t-1}$ . To proxy for market conditions, we utilize “normal” market returns captured by log returns  $M'_t$  from the Eurostoxx 50 index, the leading blue-chip index for euro area exchanges, also sourced from Bloomberg. Following Green and Bai (2008), to conduct for the differences between calendar time models, where returns are generated continuously, and trading time models, where returns are different after weekends and holidays, the

daily data on returns is adjusted using the geometric mean of returns on Mondays and after holidays:  $R'_{i,t} = R_{i,t}/n_t$  and  $M'_t = M_t/n_t$ , where  $n_t$  is the difference in calendar days between two observed trading days. More importantly for our purposes, the presence of abnormal returns after the event is captured utilizing  $u + v + 1$  daily dummies  $D_{j,t}$ , equal to 1 when  $j = t$  and zero otherwise, where  $u$  and  $v$  are the corresponding numbers of days before and after the official event date  $T$  and  $j$  is a corresponding date within the event window. Hence, the estimation sample consists of one trading year estimation period and an event window  $(T - u, \dots, T, \dots, T + v)$ , where  $T$  is the official event date, either the day of the news announcing the euro's introduction/adoption or the actual introduction/adoption itself. Data on the official government announcement of the introduction of the euro is collected from the official EU website <http://europa.eu/>. Similarly, the news dates on the intended euro introduction in the nineteen current euro area countries (11 founding and 8 non-founding members, see Appendix 1) also comes from EU sources. Descriptive statistics for daily and monthly logarithmic returns and squares of monthly zero-mean logarithmic returns, i.e. stock market volatility, are provided in Appendices 2–4.

The dummy variable approach allows us to test for the length of the abnormal responses applying an F-test on the joint significance of the parameters  $\beta_{i,j}$ ,  $j = T - u, \dots, T + v$ . To be consistent with our monthly data analysis, the rationale for which is described below, we set  $u = 0$  and examine delayed responses up to  $v = 20$  and 40 trading days ahead, i.e. approximately one and two trading months correspondingly. While admittedly an arbitrary cut-off, we set the post-event period at two trading months as we believe it is enough for the corresponding cumulative abnormal returns to return to normal; moreover, the probability of other, subsequent events related to euro accession, is relatively low, meaning we can be fairly confident that we are capturing reactions specifically to the announcement or introduction of the currency.<sup>3</sup>

Finally, as is standard in the event study literature,  $\varepsilon_{i,t}$  is a zero mean, yet potentially conditionally heteroscedastic error term. Equation 1 is estimated using ordinary least squares (OLS) *without* robust heteroscedasticity and autocorrelation consistent (HAC) corrections. As noted in Fomby and Murfin (2005), the application of HAC corrections in the event dummy case might result in misleading inference due to inconsistent estimates of dummy variable parameters  $\beta_{i,j}$ .

### *Hypotheses H2 and H3*

While an event study may capture abnormal returns within one country, we are also interested in the linkages between returns, volatility, and macroeconomic shocks across countries, as shown in our

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<sup>3</sup> Finally, this choice mirrors that of Green and Bai (2008).

Hypotheses H2 and H3. Moreover, there may be bias in the estimated parameters for dummy variables  $\beta_{i,j}$  in the event study methodology Equation 1 if important conditioning variables such as investor sentiment or monetary and macroeconomic explanatory variables (controls) are omitted. In order to model these linkages and include these conditioning variables, we turn to a univariate conditional heteroscedasticity model consisting of a regression model (2) with conditional volatility dependence (3) and (4) encapsulated in an error term  $\varepsilon_{i,m}$ :

$$R_{i,m} = \mu_i + \beta_i D_{i,m} + \pi' x_{i,m} + \varepsilon_{i,m}, \quad (2)$$

$$\varepsilon_{i,m} = \sigma_{i,m} u_{i,m}, \quad (3)$$

$$\sigma_{i,m} = v(\varepsilon_{i,m-1}, \varepsilon_{i,m-2}, \dots, \sigma_{i,m-1}, \sigma_{i,m-2}, \dots, D_{i,m}, x_{i,m}). \quad (4)$$

Where  $R_{i,m}$  denotes logarithmic returns in country  $i$  on trading month  $m$  and  $x_{i,m}$  represents a corresponding vector of macroeconomic, institutional, and sentiment controls containing exogenous variables and lags of potentially endogenous variables for the same country  $i$ . Unfortunately, as data on macroeconomic variables is, at best, available at a monthly frequency only, to link the different frequencies of the macroeconomic data and stock returns we transform the daily stock data into monthly logarithmic returns taking the difference between the first and the last trading day observations of the trading month and multiplying it by 100 to increase the convergence rate of optimization algorithms. This approach, while sacrificing some information clustered around the actual event and captured in daily data (as in the event study), allows for a wider range of macroeconomic, behavioral, and inertial controls to be included in Equation 2. Moreover, given the magnitude of the event, we anticipate that the reaction will last for more than one day, and thus can be captured in a monthly aggregation.

Event dummy variable  $D_{i,m}$  in Equation 2 then allows us to estimate the effect of the domestic euro introduction news or events on the local market returns and volatility, set at 1 during the event month and zero otherwise. Innovations  $u_{i,m}$  are assumed to be Gaussian, while all asymmetries are defined by the conditional variance function  $v(\cdot)$ . To estimate Equations (2)–(4), we utilize the statistical package *gig* written by Lucchetti and Baliotti (2011).

The set of controls  $x_{i,m}$  includes spillover effects on domestic markets, which are captured by one-month lags of log-returns from the entire euro area ( $M_{m-1}$ , as in Equation 1 and taken from the Eurostoxx 50). This approach, as in Fedorova and Saleem (2012), allows us to ascertain the impact of the news or events of the introduction of the euro in foreign markets on domestic market returns and volatility. Similarly, we anticipate that a significant result on  $M_{m-1}$  also demonstrates an inertial effect present in foreign and domestic stock returns.

Additional behavioral controls are proxied for by the inclusion of an economic sentiment indicator (ESI) for either the whole EU (ESI EU) or for the euro area (ESI EA), both sourced from Eurostat. Finally, macroeconomic controls include several measures, which can influence firm valuation, including Eurostat and the ECB data on the narrow euro money supply (M1), the US dollar and euro exchange rate, industrial production indices, harmonized consumer price indices-based inflation rates, and unemployment rates. For computational simplicity, we will assume that conditional volatility equation (4) has no other controls other than the event dummy variables.

To model the conditional volatility, we rely on an asymmetric conditional heteroscedasticity model from the asymmetric power-ARCH (APARCH) family, introduced in Ding *et al.* (1993). The conditional variance (4) is specified as:

$$\sigma_{i,m}^{\delta_i} = \omega' x_{i,m} + \kappa_i D_{i,m} + \sum_{j=1}^q \alpha_{i,j} (|\varepsilon_{i,m-j}| - \gamma_{i,j} \varepsilon_{i,m-j})^{\delta_i} + \sum_{k=1}^p \beta_{i,k} \sigma_{i,m-k}^{\delta_i}, \quad (5)$$

where power parameter  $\delta_i$  performs a Box-Cox transformation of the conditional standard deviation and is assumed to be positive (typically ranging between 0 and 2). Closer to zero values of this parameter will indicate smaller sensitivity to outliers, i.e. bigger news effects. Special values of these parameters give rise to the particular cases, which, hence, could be tested. Seeking a more parsimonious model, the values of  $p$  and  $q$  are conventionally set to 1 or 2, although deeper dependences are also possible.

The most widespread conditional volatility model utilized in an examination such as this is a GARCH model, pioneered by Bollerslev (1986), which is a special case of the APARCH model and imposes constraints of  $\delta_i = 2$ ,  $\gamma_{i,j} = 0, j = 1, \dots, q$ . However, a key drawback of GARCH is its symmetric response to positive and negative shocks, which may not be the case with regard to the introduction of the euro. In particular, asymmetric responses of equity returns to news such as euro introduction are caused by leverage effects, which force debt to equity ratios to rise because of the decline in equity value. This in turn affects investors' expectations of future cash flows and their perceptions of risk, as investors are likely to perceive their future cash flows as being riskier. The asymmetry in responses is also explained by the “*volatility-feedback*” hypothesis, which argues that if expected returns increase with rising stock volatility (likely to happen with the introduction of the euro), then stock prices should fall given the constant dividends. Bearing these arguments in mind, we include parameter  $\gamma_{i,j}$  to capture asymmetric effects and we will test if  $\gamma_{i,j}$  is significantly different from zero.

The theoretical attractiveness of the APARCH specification shown in Equation 5 must be weighed against its computational intensity, i.e. solving an asymmetric non-linear problem estimated by maximum likelihood methods and using techniques to approximate the derivatives of the

likelihood function, an intensive process even when a number of controls is small. To overcome this difficulty, we propose a two-step approach: in the first step, we assess which particular case of the volatility equation is the most probable according to APARCH estimates, using a parsimonious set of controls. For the second step, we re-estimate Equations 2, 3, and 5 as a system but using other streamlined APARCH models, including a conventional symmetric GARCH model, Geweke's (1986) and Pantula's (1986) asymmetric log-GARCH model (where  $\delta_i \rightarrow 0$ ), Glosten et al.'s (1993) GJR model ( $\delta_i = 2$ ) and Zakoian's (1994) TARCH model ( $\delta_i = 1$ ) and TARCH's symmetric counterpart, the Taylor and Schwert TS-GARCH.

#### 4. Empirical findings

##### 4.1. Event study

##### 4.1.1 Founding Members

In order to examine Hypothesis H1, we begin with the event study methodology of Equation 1 to trace the effects of the euro's introduction on its founding members. One of the immediate distinguishing factors of the founding members from members who were to join later (other than the possible endogeneity in timing the introduction of the euro) was the long run-up to the euro and the reforms required resulted in two discrete and separate announcements regarding the euro's introduction before the currency was even actually introduced. The first announcement on the euro's introduction was made simultaneously across the eleven founding members on June 17, 1997 with the adoption of the Stability and Growth Pact on fiscal rectitude within the euro area, while the second announcement, the European Council's decision acknowledging that eleven countries had met the necessary conditions to introduce the single currency on 1 January 1999, occurred also simultaneously across EU states on March 3, 1998.

**Table 1:** *Founding members' market reaction to the euro introduction related events*

| Panel A: First announcement, 17.06.1997  |           |                |  |              |         |               |         |                     |     |
|--|-----------|----------------|--|--------------|---------|---------------|---------|---------------------|-----|
| Country                                  | Intercept | Market returns | Significant abnormal returns at lags (+/-) | CAR, 1 month | p-value | CAR, 2 months | p-value | Adj. R <sup>2</sup> | n   |
| AT                                       | -0.0003   | 0.48***        | 9, 11, 22, 24, 26, 28, 38                  | 0.029        | 0.22    | 0.057***      | 0.01    | 0.39                | 291 |
| BE                                       | 0.0002    | 0.63***        | 9, 11, 13, 31, 33, 34, 38                  | 0.002*       | 0.06    | -0.051***     | 0.00    | 0.54                | 293 |
| DE                                       | -0.0001   | 0.98***        | 9, 19, 26, 28, 34, 36                      | 0.021        | 0.16    | 0.032**       | 0.02    | 0.70                | 295 |
| ES                                       | 0.0003    | 0.83***        | 11, 22, 23, 26, 27                         | 0.020        | 0.69    | -0.049***     | 0.00    | 0.52                | 292 |
| FI                                       | 0.0004    | 0.87***        | 27, 34                                     | 0.022        | 0.89    | 0.055         | 0.33    | 0.45                | 293 |
| FR                                       | -0.0000   | 0.99***        | 6, 11                                      | -0.021       | 0.40    | -0.063        | 0.65    | 0.60                | 294 |
| IE                                       | 0.0005    | 0.50***        | 32, 38                                     | 0.000        | 0.61    | 0.039         | 0.23    | 0.36                | 295 |
| NL                                       | 0.0002    | 1.10***        | 22, 31, 39                                 | 0.022        | 0.96    | -0.004        | 0.27    | 0.70                | 295 |
| PT                                       | 0.0011*** | 0.38***        | 11, 12, 14, 17, 37                         | 0.015**      | 0.03    | 0.037         | 0.17    | 0.17                | 282 |
| Panel B: Second announcement, 05.03.1998 |           |                |  |              |         |               |         |                     |     |
| AT                                       | -0.0004   | 0.73***        | 16, 33-35, 38, 39                          | 0.014        | 0.83    | 0.046**       | 0.03    | 0.52                | 288 |
| BE                                       | -0.0002   | 0.73***        | 24   | 0.022        | 0.99    | 0.053         | 0.81    | 0.66                | 290 |
| DE                                       | 0.0001    | 1.06***        | 23, 31, 38, 39, 40                         | -0.016       | 0.91    | -0.046***     | 0.00    | 0.75                | 290 |
| ES                                       | 0.0005    | 0.80***        | 11, 29, 35                                 | 0.054        | 0.81    | 0.021         | 0.35    | 0.65                | 286 |
| FI                                       | 0.0005    | 0.97***        | 11, 13, 29, 36                             | -0.023       | 0.28    | 0.050*        | 0.08    | 0.64                | 289 |
| FR                                       | -0.0003   | 0.95***        | 18, 40                                     | 0.048        | 0.46    | 0.058         | 0.63    | 0.70                | 291 |

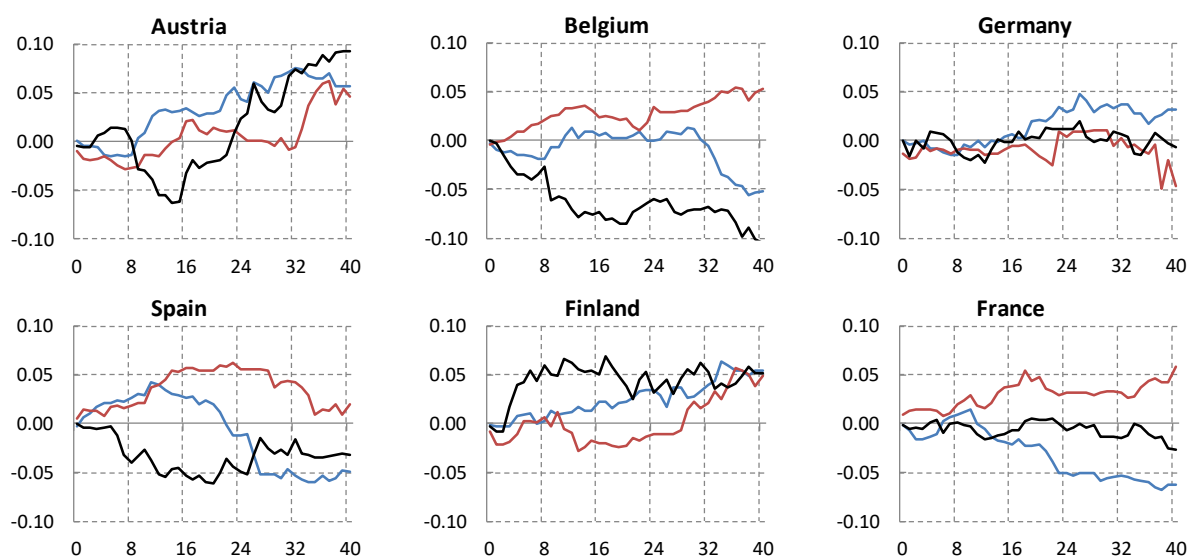
|   |           |         |                              |           |      |           |      |      |     |
|---|-----------|---------|------------------------------|-----------|------|-----------|------|------|-----|
| IE  | 0.0014*** | 0.46*** | 0, 9, 18, 24, 38             | -0.011    | 0.14 | -0.046**  | 0.03 | 0.43 | 290 |
| NL  | 0.0001    | 1.07*** | <b>36, 38</b>                | -0.036    | 0.93 | -0.013    | 0.66 | 0.79 | 291 |
| PT  | 0.0013*** | 0.61*** | 36, 38                       | 0.035     | 0.96 | 0.038     | 0.59 | 0.45 | 282 |
| <b>Panel C: Euro introduction event, 01.01.1999</b> |           |         |                              |           |      |           |      |      |     |
| AT  | -0.0012   | 0.67*** | <b>9, 16, 23, 26, 31</b>     | -0.021    | 0.11 | 0.093**   | 0.02 | 0.51 | 289 |
| BE  | 0.0006    | 0.61*** | 2, 9, 27, 37                 | -0.085*** | 0.00 | -0.105*** | 0.00 | 0.66 | 292 |
| DE  | -0.0006   | 0.93*** | <b>4, 27, 34</b>             | 0.003     | 0.35 | -0.006    | 0.47 | 0.74 | 293 |
| ES  | 0.0005    | 0.94*** | 7, <b>22, 26, 27, 32, 33</b> | -0.061    | 0.34 | -0.032*   | 0.08 | 0.79 | 287 |
| FI  | 0.0008    | 0.99*** | <b>3, 4, 24</b>              | 0.038     | 0.26 | 0.052     | 0.27 | 0.64 | 290 |
| FR  | 0.0004    | 0.94*** | 6, 29, 34, 39                | 0.004     | 0.60 | -0.027    | 0.49 | 0.87 | 290 |
| IE  | 0.0001    | 0.52*** | <b>2, 21</b>                 | 0.003     | 0.61 | 0.054     | 0.45 | 0.33 | 289 |
| IT  | -0.0002   | 1.04*** | <b>3, 11, 27, 36</b>         | -0.021    | 0.29 | 0.014     | 0.24 | 0.74 | 290 |
| NL  | 0.0001    | 0.95*** | 3, 12, 19, <b>26, 33</b>     | -0.062*** | 0.00 | -0.052*** | 0.01 | 0.85 | 293 |
| PT  | -0.0001   | 0.81*** | -                            | 0.005     | 0.84 | 0.019     | 0.94 | 0.53 | 287 |

Significance levels: \* 10%, \*\* 5%, \*\*\* 1%

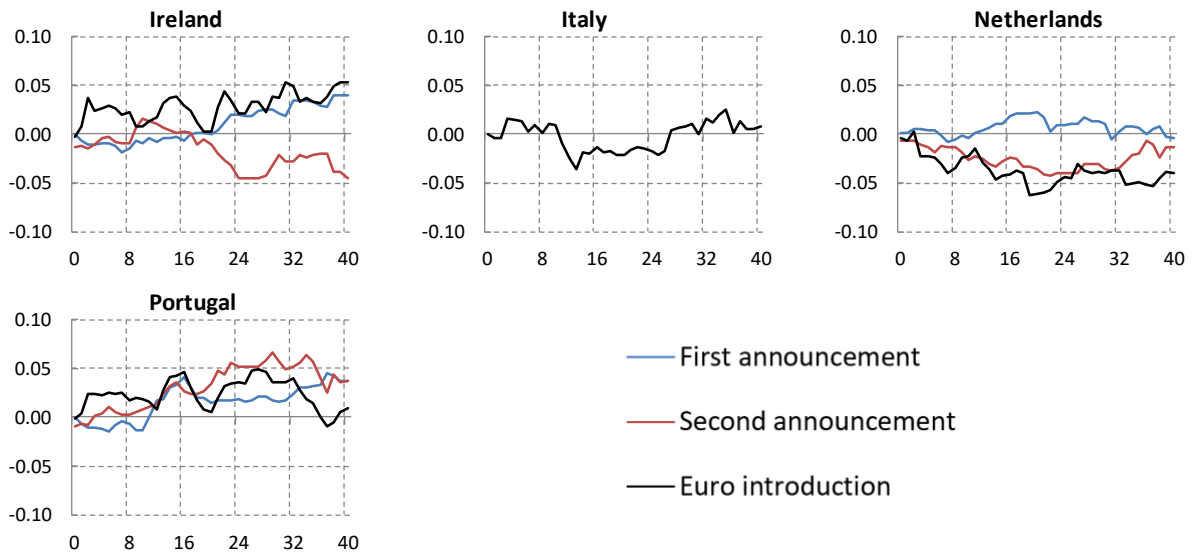
Notes: significant lags denote at least at 5% level significant abnormal returns with positive values marked in bold. CAR stands for cumulative abnormal returns, where 1 month is tested after 20 trading days and 2 months after 40 trading days. Columns for p-value are used to test the joint significance of dummy variables by a corresponding F-test for omitted variables up to 1 trading month and 2 trading months. Due to the missing observations, Italy and Luxembourg are not presented in Panel A and B; Luxembourg is also excluded from euro introduction Panel C.

Table 1 shows the result of the event study surrounding these two separate announcements, with Panel A examining abnormal returns surrounding the first announcement in 1997 and Panel B the returns associated with the second announcement in 1998 (Panel C shows the results surrounding the actual introduction of the currency). The results indicate that, even after accounting for highly significant and positive market effects, the average remaining daily returns varied from  $-0.0012$  to  $0.0014$  (any statistically significant deviations from the expected values are conventionally interpreted as abnormal returns or ARs). Despite the simultaneous announcements and introduction of euro events across the founding members, we see heterogeneous responses of domestic stock markets: this can be clearly seen in the reaction to the first announcement event, shown in Panel A, which appears to encompass country-specific attitudes towards the euro (euro enthusiastic or eurosceptic), a trait which can also be observed in the country's cumulative abnormal returns (CARs, shown in Figure 3).

**Figure 3:** Cumulative abnormal returns in founding euro members



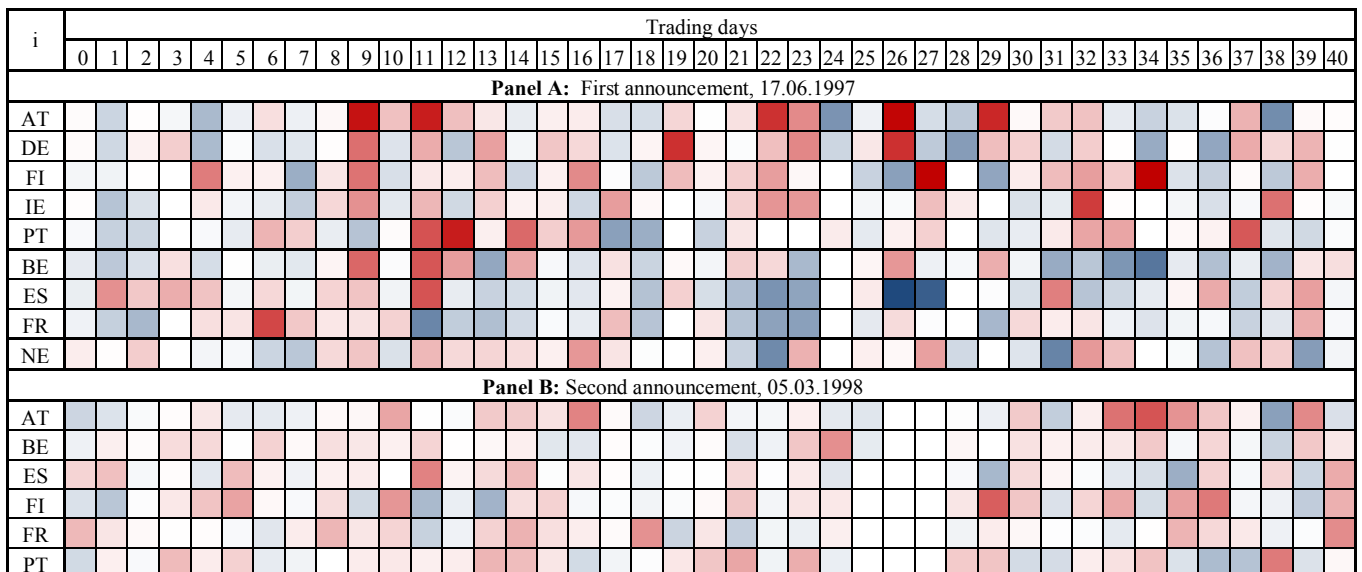


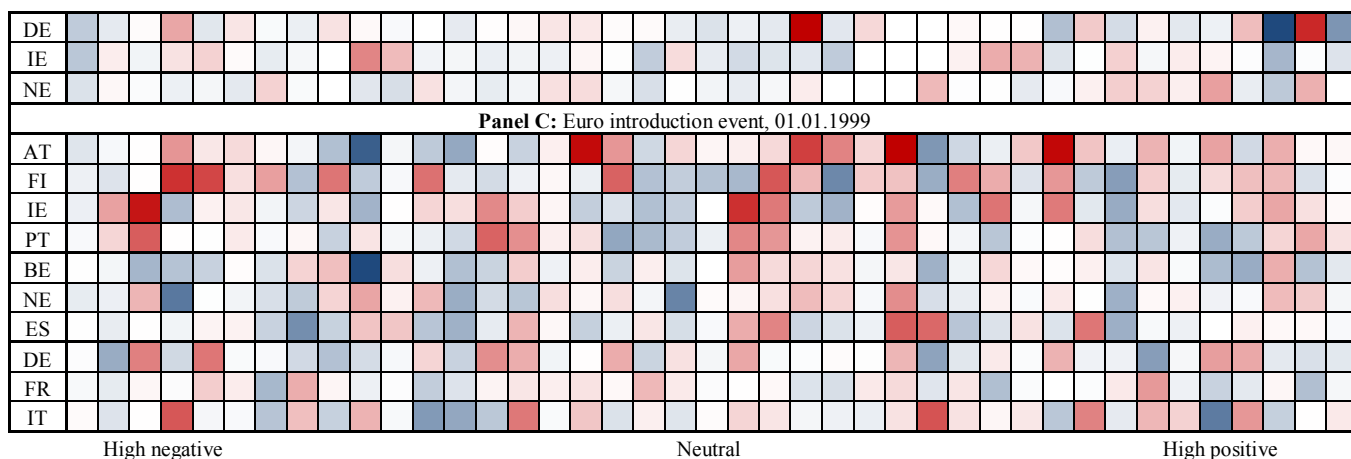


For example, German and Austrian financial markets, geographically proximate and economically interlinked, appeared to welcome the first announcement event, as did future members of the euro area situated on the periphery of the EU (Portugal, Ireland, and Finland). On the other hand, initial positive (abnormal) responses in Belgium, France, and Spain dissipated within a few trading weeks to a eurosceptic view, while Dutch traders showed little effect.

Overall, the analysis of individual abnormal returns and the heat map shown in Figure 4 show that it took about two trading weeks for markets to form a response to the news of the euro's introduction or, alternately, to wait for lingering uncertainty surrounding the announcement to be resolved. After this initial two-week period, the second wave of ARs was observed approximately five trading weeks after the announcement, an effect that actually shaped and strengthened existing behavioral patterns.

**Figure 4:** *Founding members' heat map of abnormal returns to the first, second announcements of the euro introduction and the euro introduction events.*





Notes: The heat map depicts abnormal daily returns (ARs), where darkest blue color represents the largest negative values, while dark red color the largest positive values of ARs for each corresponding panel. Neutral values represent close to zero ARs. The magnitude of ARs does not imply the statistical significance of deviations. Significant values are marked in Table 1.

Panel B of Table 1, showing market responses to the second announcement of the euro's introduction, reveals behavioral shifts in several countries. Austria and Finland continue to show positive CARs, but significant negative CARs can be observed in the second trading month for German and Irish markets. Dutch traders again responded neutrally, with slightly negative, but insignificant daily ARs, and on average, delays in responses were higher for the second announcement (except in Ireland). As shown in the heat map, and unsurprisingly, financial markets were also less surprised by the second announcement compared to the first announcement, as the daily ARs were mild or neutral and much more delayed in the first round.

Finally, Panel C in Table 1 shows the response of founding member financial markets to the actual introduction of the euro. Immediately, we can see that euro area markets responded much faster, as the first abnormal returns were already detected within the first and second trading weeks. Significant negative cumulative reactions were observed for the small open economies of Belgium and the Netherlands, while Austria, Finland, and Portugal responded positively (but, again, the Austrian market's CARs were found to be statistically significant). According to the heat map in Panel C, the reaction of the largest euro area economies – Germany, France, and Italy – in this case, was neutral, signifying that information regarding the euro introduction had long been priced-in.

In sum, these findings confirm Green and Bai's (2008) argument that the introduction of euro was a well-known and scheduled event of the third stage of EMU, although our results vary from this earlier work. All founding members were required to meet the convergence criteria for monetary and fiscal policy and inflation to be an eligible member for EMU. However, the schedule of the third stage was flexible and could have started between 1996 and 1999, and only the countries meeting the criteria could join the euro area. Therefore, there was some uncertainty about the number of joining countries, the timing, the conditions to be imposed on the joining countries and the impact of the euro

introduction on economies and markets of the joining countries. But this uncertainty should have been offset with the news of the euro conversion rates fixed in May 1998, which was announced before the conversion itself. In spite of this reality, we have found asymmetry in market responses, dependent on the particular country, resulting in either observed negative (eurosceptic) or positive (euro enthusiastic) CARs after one or two trading months. Unfortunately, Table 1 shows that this effect was mainly statistically insignificant, with significance observed only in a few founding members (Austria on the positive side and the Netherlands and Belgium on the negative side).

Indeed, Austria is the only country where the stock market responded significantly positively in all 3 panels. As it will be shown in section 4.2, the deviation from historically-observed expected returns was mostly led by increases in the domestic economic sentiment index, implying that Austrian traders overreacted to euro events and the nature of the abnormality is a behavioral feature divorced from fundamentals. Such trading behavior appears to have been influenced by the winding path of Austria to the euro (Hochreiter and Tavlas 2005); in particular, the idea of euro area accession began fairly early with debates on the Exchange Rate Mechanism (ERM) and confidence that Austria would be able to fulfil interest rate and inflation rate criteria (but some uncertainty regarding the country's fiscal path). However, the collapse of the government in 1995 jeopardized Austria's ability to adopt the euro in the first wave precisely on fiscal grounds, and the successor government had to implement a fiscal consolidation plan to achieve the euro area fiscal criteria by 1997. In this sense, Austrian traders appeared to view the overall sound fiscal policy immediately prior to the euro as locked-in, considering the 1992–1995 fiscal deficits as a temporary phenomenon that euro membership would prevent a return to.

Such a response played out almost entirely in reverse in the Low Countries, which did not undergo such a drastic fiscal consolidation prior to the introduction of the euro. As Table 1 showed, there were pronounced negative reactions in the Netherlands and Belgium to euro introduction, responses we attribute to expected higher uncertainty about convergence criteria, credibility, fiscal policy adjustments, and market effects.<sup>4</sup> On the other hand, the *ex-post* analysis shows that there were no fundamental reasons for such pessimistic views: when looking at the fiscal experience in both countries *ex-post*, Fahrolz and Mohl (2003) found that the Netherlands and Belgium improved their budgetary positions much faster than the rest of the founding members. For example, in Belgium, the general government financial balance moved from a deficit of 2% of GDP in 1997 to a surplus of 0.4% in 2001, while in the Netherlands, the fiscal stance went from a deficit of 1.1% of GDP in 1997

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<sup>4</sup> These findings are in line with Green and Bai (2008), where significant negative CARs were also detected for Belgium and the Netherlands.

to a slight (0.1%) surplus in 2001. Moreover, the decrease in the debt-to-GDP ratio in 1997–2001 was around 12% of GDP for Belgium and 17% of GDP for the Netherlands, while in France, Luxembourg, and Germany it improved just by 1–2% of GDP.

#### 4.1.2 Non-Founding Members

The founding members of the euro were more intimately acquainted with and invested in the euro's launch, perhaps muting the effect on returns due to the greater information available in the long run-up. For non-founding members, however, there was less information (only one announcement) and greater informational asymmetry on the possible consequences of the euro's adoption, an asymmetry which may have been contingent on the timing of the introduction of the common currency (our Hypothesis 2). We turn to examining the responses of these eight non-founding members of the euro area, the results of which are reported in Table 2 for the euro adoption announcement news (Panel A) and the actual euro adoption event (Panel B).

**Table 2:** *Non-Founding members' market reactions to the euro adoption announcement and the euro adoption events*

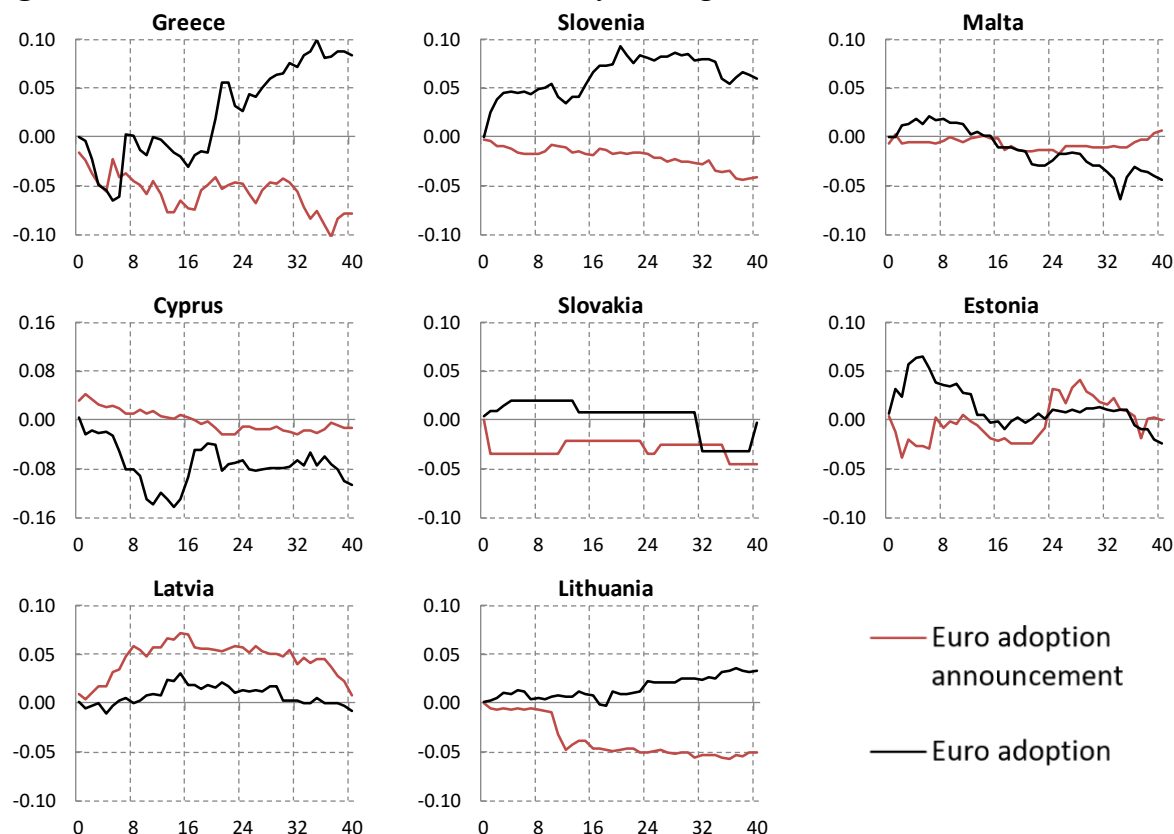
| Panel A: Euro adoption announcement |            |           |                |  |              |         |               |         |                     |     |
|-------------------------------------|------------|-----------|----------------|--|--------------|---------|---------------|---------|---------------------|-----|
| Country                             | Date       | Intercept | Market returns | Significant abnormal returns at lags (+/-) | CAR, 1 month | p-value | CAR, 2 months | p-value | Adj. R <sup>2</sup> | n   |
| GR                                  | 20.06.2000 | -0.0005   | 0.29***        | -  | -0.041       | 1.00    | -0.079        | 1.00    | -0.07               | 293 |
| SI                                  | 02.03.2006 | 0.0003    | -0.01          | -  | -0.016       | 1.00    | -0.043        | 1.00    | -0.11               | 278 |
| CY                                  | 16.05.2007 | 0.0018**  | 0.55***        | <b>0</b>                                   | -0.012       | 1.00    | -0.012        | 0.98    | 0.01                | 288 |
| MT                                  | 16.05.2007 | -0.0001   | 0.02           | -  | -0.014       | 1.00    | 0.004         | 0.97    | -0.09               | 283 |
| SK                                  | 07.05.2008 | -0.0001   | 0.18           | -  | -0.021       | 0.43    | -0.045        | 0.40    | 0.01                | 76  |
| EE                                  | 03.07.2010 | 0.0021**  | 0.18***        | <b>7, 24</b>                               | -0.024       | 0.82    | 0.003         | 0.86    | 0.00                | 295 |
| LV                                  | 09.07.2013 | 0.0008*   | 0.08**         | <b>5, 32, 40</b>                           | 0.054        | 0.22    | 0.022         | 0.32    | 0.03                | 291 |
| LT                                  | 23.07.2014 | 0.0003    | 0.14***        | <b>11, 12</b>                              | -0.048***    | 0.00    | -0.051*       | 0.09    | 0.10                | 291 |
| Panel B: Euro adoption event        |            |           |                |  |              |         |               |         |                     |     |
| GR                                  | 01.01.2001 | -0.0014   | 0.28***        | <b>7, 21</b>                               | 0.018        | 0.28    | 0.087         | 0.69    | 0.03                | 291 |
| SI                                  | 01.01.2007 | 0.0012*** | 0.00           | <b>1, 2, 11, 16, 20, 35</b>                | 0.093***     | 0.00    | 0.063***      | 0.00    | 0.11                | 284 |
| CY                                  | 01.01.2008 | 0.0004    | 0.76***        | <b>1, 6, 7, 10, 16, 17, 21</b>             | -0.040***    | 0.00    | -0.100***     | 0.00    | 0.41                | 280 |
| MT                                  | 01.01.2008 | -0.0000   | 0.08**         | <b>2, 12, 16, 21, 34, 35, 36</b>           | -0.014***    | 0.00    | -0.040        | 0.15    | 0.17                | 269 |
| SK                                  | 01.01.2009 | -0.0050   | 0.03           | -  | 0.008        | 1.00    | -0.032        | 1.00    | -0.14               | 62  |
| EE                                  | 01.01.2011 | 0.0018**  | 0.30***        | <b>3</b>                                   | 0.007        | 0.65    | -0.020        | 0.99    | 0.01                | 292 |
| LV                                  | 01.01.2014 | 0.0007    | 0.05           | <b>13</b>                                  | 0.016        | 0.76    | -0.003        | 0.98    | -0.06               | 287 |
| LT                                  | 01.01.2015 | 0.0002    | 0.08**         | <b>17, 19, 24</b>                          | 0.011        | 0.56    | 0.032         | 0.54    | -0.02               | 291 |

Significance levels: \* 10%, \*\* 5%, \*\*\* 1%

Notes: see Table 1.

As can be seen in Table 2, the non-founding countries have very weak links to Eurostoxx variables, reflected in small and often insignificant elasticity parameters for market returns, and average daily returns vary from -0.005 to 0.0021. Moreover, the adjusted R-Squared values are significantly lower than the 0.36–0.87 range found for the founding member regressions, due mainly to the inclusion of many dummy variables which have turned out to be insignificant.

**Figure 5:** Cumulative abnormal returns in non-founding euro members

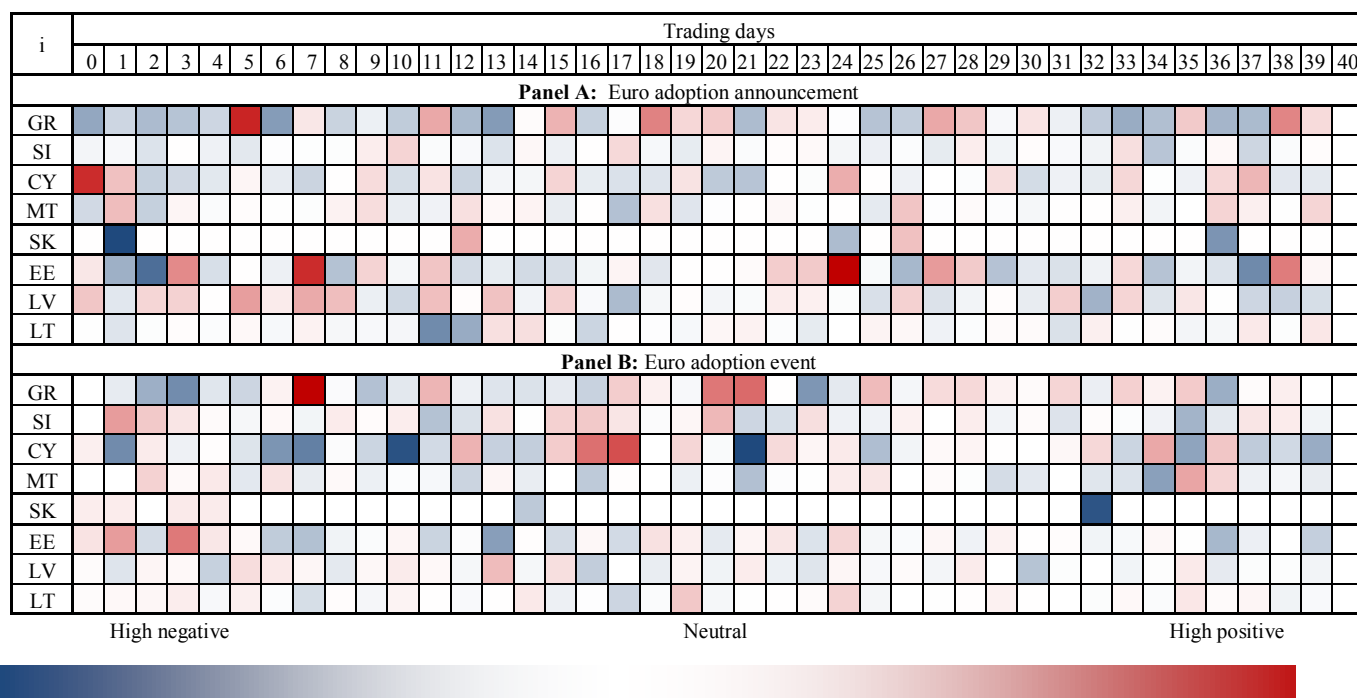


Overall, the pre-crisis period showed the little-to-no response of local markets to the news on the adoption of the euro, as CARs in this period were slightly negative for all countries which adopted the euro pre-crisis (Greece, Slovenia, Cyprus, Malta, and Slovakia) but insignificant (Figure 5). Similarly, the heat maps are shown in Figure 6 also indicate a neutral stance for most markets pre-crisis on the announcement of the euro's introduction. In these cases, it is also probable that markets had priced in the euro's introduction and, occurring in an era of relative calm, (good) news on the euro had little additional information for investors.

However, and in stark contrast, there are highly significant heterogeneous CARs for pre-crisis euro adoption events. As shown in Panel B of Table 2, markets in Cyprus and Malta exhibited a significant level of euro-skepticism immediately following the euro's introduction, while Slovenian markets were significantly positive in their assessment of the currency. The reason for these results may be traced back to the exigencies of the countries involved. In the first instance, the island countries of Cyprus and Malta share many similarities: Cyprus has experienced substantial macroeconomic and financial imbalances combined with a growing offshore banking sector not in line with the *acquis*, while Malta has also been plagued with extensive fiscal issues, including an

expanding government deficit and a bloated public sector (Van Eden *et al.* 2000).<sup>5</sup> Second, Malta and Cyprus adopted a similar “big bang” approach in switching over to the euro without a transition period, an abrupt change that created fears in the markets of immediate price increases on the occasion of the changeover in both countries (Lomas, 2007).

**Figure 6: Non-Founding members’ heat map of abnormal returns with the euro adoption announcement and the euro adoption events.**



Notes: see notes on Figure 4. For corresponding dates of events see Appendix 1 and significant ARs in Table 2.

Contrary to this experience, euro adoption in Slovenia was also highly debated by the public, with opponents and proponents of an early adoption both making their case in the press. While opponents preferred a slow approach with prolonged monetary independence, the views on early adoption dominated and resulted in the government pledging for rapid euro adoption. The ongoing discussions led to presumably higher uncertainty, but, nevertheless, the European Commission (2007) had very positive views on Slovenia’ changeover to the euro: one year after the event, 95% of Slovenians confirmed that the changeover had been smooth and efficient, and 92% of Slovenians were happy with the level of information they had received from the government. And, although Slovenia also took a “big bang” approach in adopting the euro, it is possible that the optimism surrounding the

<sup>5</sup> However, whereas the Cypriot population mainly welcomed the euro, the Maltese exhibited intense domestic disagreement on even the question of EU membership, and the introduction of the euro also occasioned deep divisions in society.

adoption meant that inflationary fears were subsumed to the perceived benefits that the euro would bring.

Turning to the post-crisis period, all Baltic countries announced and adopted euro in the post-crisis period with the official euro adoption coming more as a formality rather than an unanticipated event; indeed, in addition to the local currency, the Baltics had all become euroized to some extent, with Levasseur (2015) noting that in Lithuania at the end of 2014, 25% of bank deposits were denominated in euros, as were 75% of loans (in Latvia and Estonia, approximately 90% of loans were in euros). It was perhaps this familiarity with the euro that explains the results in Table 2, namely that the announcement of euro introduction was greeted with little fanfare in Latvia and Estonia, while the introduction of the euro had little effect on CARs in all three of the economies (the heat map in Figure 6 also shows that any reactions to euro news came on the adoption new rather than the actual introduction of the currency).

The only outlier from these patterns is the significant negative Lithuanian reaction to the euro adoption news, a fact which can be attributed to the relative unpopularity of the country actually adopting the euro (public polls held before the event revealed that only 44% of respondents believed in a positive effect of the euro on Lithuania's economy, while 48% of respondents thought it would be negative).<sup>6</sup> This pessimism on the euro almost certainly drove higher levels of uncertainty in Lithuanian financial markets, resulting in negative ARs when the euro introduction was announced. The reality of the euro introduction, however, had little effect, suggesting that the political worries surrounding the euro dissipated when financial markets saw the economic benefits.

## 4.2. *Univariate conditional heteroscedasticity models*

### 4.2.1 *Pre-testing of asymmetric effects*

Before directly testing Hypotheses H2 and H3, it is important to establish that there is indeed asymmetry in the volatility responses to news of euro introduction, and how this impacts the persistence of volatility and the reaction to outliers. As noted above, we use a two-step process of estimation, first with an unrestricted APARCH(1, 1) model and second with model restrictions for the power ( $\delta$ ) and asymmetry ( $\gamma$ ) parameters; to ascertain best fit of the restricted model, we base our choice on minimization of the AIC criterion.

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<sup>6</sup> Introduction of the euro in Lithuania. Flash Eurobarometer 402. September 2014; Accessed on [http://ec.europa.eu/commfrontoffice/publicopinion/flash/fl\\_402\\_en.pdf](http://ec.europa.eu/commfrontoffice/publicopinion/flash/fl_402_en.pdf)

**Table 3:** Unrestricted APARCH (1, 1) models and restricted model selection

| Panel A: Founding members     |                     |                            |                     |          |         |                  |     |
|-------------------------------|---------------------|----------------------------|---------------------|----------|---------|------------------|-----|
| Country                       | Intercept, $\omega$ | Power, $\delta$ (st. err.) | Asymmetry, $\gamma$ | $\alpha$ | $\beta$ | Restricted model | n   |
| AT                            | 3.37**              | 1.65(2.49)                 | 0.97**              | 0.09     | 0.56*** | GJR              | 230 |
| BE                            | 1.92***             | 1.28(0.92)                 | 0.53**              | 0.32***  | 0.49*** | TARCH            | 230 |
| DE                            | 0.09                | 1.80(1.11)                 | -0.18               | 0.11***  | 0.88*** | GARCH            | 230 |
| ES                            | 0.56**              | 0.64(1.45)                 | 0.48                | 0.11     | 0.85*** | TS-GARCH         | 230 |
| FI                            | 0.18                | 2.22(0.73)                 | -0.04               | 0.15***  | 0.84*** | GARCH            | 230 |
| FR                            | 0.06                | 2.17(2.47)                 | 0.03                | 0.08     | 0.86*** | GARCH            | 230 |
| IE                            | 1.00                | 3.07(11.43)                | 0.09                | 0.13     | 0.74*** | GARCH            | 222 |
| IT                            | 0.61                | 0.90(0.89)                 | -0.16               | 0.17***  | 0.79*** | TS-GARCH         | 207 |
| LU                            | 3.03**              | 0.47(0.49)                 | 0.05                | 0.28***  | 0.61*** | TS-GARCH         | 194 |
| NL                            | 0.33                | 0.37(0.51)                 | -0.10               | 0.14**   | 0.83*** | TS-GARCH         | 230 |
| PT                            | 1.89                | 2.26(3.27)                 | -0.04               | 0.12     | 0.75*** | GARCH            | 230 |
| Panel B: Non-founding members |                     |                            |                     |          |         |                  |     |
| GR                            | 2.86*               | 0.74(0.51)                 | 0.35*               | 0.17**   | 0.81*** | TARCH            | 230 |
| SI                            | 0.70                | 0.41(0.51)                 | -0.21               | 0.13**   | 0.86*** | TS-GARCH         | 177 |
| CY                            | 9.39                | 1.20(0.89)                 | 0.99**              | 0.06*    | 0.87*** | TARCH            | 126 |
| MT                            | 4.33***             | 1.13(0.78)                 | -0.53**             | 0.25***  | 0.58*** | TARCH            | 230 |
| EE                            | 1.72                | 0.23(0.49)                 | -0.26               | 0.19**   | 0.81*** | TS-GARCH         | 222 |
| LV                            | 1.70                | 0.32(0.42)                 | -0.31               | 0.16***  | 0.83*** | TS-GARCH         | 182 |
| LT                            | 0.90                | 1.50(0.76)                 | -0.01               | 0.19***  | 0.81*** | GARCH            | 182 |

Significance levels: \* 10%, \*\* 5%, \*\*\* 1%

Notes: Slovakia has no continuous monthly data and is removed from our further analysis. To stabilize the estimation algorithm convergence all variables, except dummy variables, were transformed multiplying by a factor 100.

The results of this pre-specification strategy are shown in Table 3, indicating that asymmetric conditional volatility models are not necessarily appropriate for euro area stock markets. Only five cases out of 18 showed significant asymmetric effects mostly described by TARCH models, with the Austrian stock market best described by a GJR-GARCH approach. The distribution of the significant asymmetric effects was split between founding and non-founding members, with two founding and three non-founding members displaying asymmetric effects to the euro introduction. With regard to non-founding members, such effects were found for insular small open economies of Malta and Cyprus, and Greece heavily hit by the global crisis. Somewhat surprisingly, Maltese traders tend to over-react to *positive* news, while Greece and Cyprus have an asymmetric response which follows more conventional patterns.

Our pre-testing exercise also revealed that more than half of EA stock markets are less sensitive to outliers, since power transformation parameter  $\delta_i$  is approximately equal to one. At the same time, the persistence of volatility equations is high as the inertia related  $\beta$  parameters are relatively higher than  $\alpha$ . Finally, symmetric GARCH or TS-GARCH models, including three cases for post-crises entrants (i.e. the Baltic States) are the models of best fit for the rest of the countries under examination.

#### 4.2.2 Founding Members

Following Engle *et al.* (1990), the next step is to test for the presence of volatility spillover effects conditioned on local and foreign macroeconomic conditions; this first step continues our discussion presented in the event study but includes additional macroeconomic and behavioral controls. As noted above, this new specification includes market spillovers, an economic sentiment index (ESI) for both



the EU and the euro area, narrow money (M1), and industrial production, unemployment, and inflation to explain the nature of abnormality observed in daily stock market returns. Using these controls in addition to the euro event dummies (D1news for the first announcement and D2news for the second announcement), we may now proceed to explicitly testing Hypotheses H2 and H3.

**Table 4:** *Founding members' market reaction to euro adoption announcement and the euro adoption event, conditional mean equation*

| Country                                  | AT                 | BE                | DE                 | ES                 | FI                 | FR                 | IE                 | IT                 | LU                | NL                 | PT                 |
|--|--------------------|-------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|-------------------|--------------------|--------------------|
| <b>Panel A: euro announcement events</b> |                    |                   |                    |                    |                    |                    |                    |                    |                   |                    |                    |
| D1news                                   | -2.85              | 0.14              | -2.08              | 2.04               | -2.77              | 2.80**             | -3.19              | --                 | --                | 0.98               | 2.91               |
| D2news                                   | -0.38              | 3.24 <sup>+</sup> | -2.28              | 4.69 <sup>+</sup>  | -4.65              | 3.68***            | -2.56              | 10***              | --                | -3.16 <sup>+</sup> | 7.04*              |
| Dnews.gr                                 | 0.96               | 3.65 <sup>+</sup> | -2.06              | -0.07              | -2.90              | 1.41 <sup>+</sup>  | 1.21               | 4.16 <sup>+</sup>  | 7.19 <sup>+</sup> | 3.35 <sup>+</sup>  | 2.64               |
| Dnews.si                                 | -0.12              | 0.06              | -1.20              | 4.38 <sup>+</sup>  | 1.23               | -0.94              | 2.42               | 1.32               | -0.47             | -0.41              | 7.23*              |
| Dnews.mt.cy                              | 0.24               | -0.34             | 2.39 <sup>+</sup>  | 4.12 <sup>+</sup>  | 2.74               | -0.10              | 1.20               | -2.93              | 1.71              | -0.96              | 6.48 <sup>+</sup>  |
| Dnews.sk                                 | 6.62 <sup>+</sup>  | -6.50**           | 0.02               | -1.58              | 1.46               | -1.00              | -14***             | -4.82 <sup>+</sup> | -7.19**           | -6.50***           | -5.79 <sup>+</sup> |
| Dnews.ee                                 | 1.61               | -1.71             | 0.96               | -0.89              | 0.94               | -0.23              | 5.17 <sup>+</sup>  | 1.10               | 1.09              | 1.13               | 2.23               |
| Dnews.lv                                 | -1.60              | -1.08             | -0.97              | 5.49*              | 2.55               | -0.43              | -4.32 <sup>+</sup> | -1.64              | -4.24             | -2.84 <sup>+</sup> | -1.25              |
| Dnews.lt                                 | -4.94 <sup>+</sup> | 2.02              | -0.84              | -0.05              | 4.18               | -0.66              | 0.86               | -0.24              | 3.07              | 1.34               | -11***             |
| <b>Panel B: euro introduction events</b> |                    |                   |                    |                    |                    |                    |                    |                    |                   |                    |                    |
| Deuro                                    | -7.80 <sup>+</sup> | -5.23*            | -4.04 <sup>+</sup> | -4.76 <sup>+</sup> | 0.95               | 2.63**             | -2.14              | -1.18              | --                | -6.02**            | 2.75               |
| Deuro.gr                                 | 3.24               | 0.27              | 5.39**             | 7.19**             | -19***             | 1.31 <sup>+</sup>  | 1.68               | 3.51 <sup>+</sup>  | 6.96 <sup>+</sup> | 1.55               | 8.95**             |
| Deuro.si                                 | 0.19               | -0.02             | 0.45               | 1.63               | 3.52               | 0.04               | -2.09              | -0.20              | 2.38              | -0.60              | 1.29               |
| Deuro.mt.cy                              | -5.53 <sup>+</sup> | 0.27              | -1.43              | -0.25              | 3.66               | -0.23              | 7.04*              | 4.33 <sup>+</sup>  | -0.49             | -1.36              | -3.29              |
| Deuro.sk                                 | 6.35 <sup>+</sup>  | 5.96*             | 1.18               | -1.28              | 2.35               | 0.44               | 8.09*              | 0.17               | 3.20              | 10.72***           | 6.56 <sup>+</sup>  |
| Deuro.ee                                 | -5.53 <sup>+</sup> | -1.30             | -4.17*             | 4.46 <sup>+</sup>  | -3.72              | 0.12               | -6.13 <sup>+</sup> | 2.93 <sup>+</sup>  | -10.99**          | -4.06*             | -0.78              |
| Deuro.lv                                 | 2.08               | 1.00              | 0.46               | 2.35               | -1.02              | 0.08               | 4.31 <sup>+</sup>  | 6.07**             | 1.27              | -1.03              | 2.67               |
| Deuro.lt                                 | -3.37              | 3.63 <sup>+</sup> | 1.97               | -5.95*             | 0.49               | 2.04 <sup>+</sup>  | -0.89              | 1.27               | -1.26             | -0.27              | -0.86              |
| <b>Panel C: control variables</b>        |                    |                   |                    |                    |                    |                    |                    |                    |                   |                    |                    |
| Intercept                                | 0.49               | 0.56*             | 0.29 <sup>+</sup>  | 0.09               | -0.56              | -0.03              | -0.29              | -0.02              | 0.35              | 0.18               | 0.19               |
| Market spillover                         | 0.68***            | 0.68***           | 1.07***            | 0.89***            | 1.07***            | 0.93***            | 0.70***            | 0.99***            | 0.89***           | 0.96***            | 0.79***            |
| ESI, EA                                  | 0.04               | 0.03              | -0.31 <sup>+</sup> | 0.64*              | 0.39               | 0.30**             | 0.08               | 0.21               | 0.36              | 0.09               | 0.87*              |
| ESI, EU                                  | 0.48               | 0.18              | 0.27 <sup>+</sup>  | -0.64*             | -0.29              | -0.19 <sup>+</sup> | 0.28               | -0.10              | 0.15              | 0.02               | -0.61 <sup>+</sup> |
| M1                                       | -0.25              | -0.8***           | -0.08              | 0.12               | 1.04               | -0.02              | 0.52               | -0.48*             | -0.22             | -0.21              | -0.37              |
| <b>Country level controls</b>            |                    |                   |                    |                    |                    |                    |                    |                    |                   |                    |                    |
| ESI                                      | 0.14 <sup>+</sup>  | 0.20*             | 0.03               | 0.02               | 0.06               | 0.00               | --                 | 0.19*              | -0.00             | 0.12 <sup>+</sup>  | -0.07              |
| Industrial production                    | -0.03              | --                | 0.12               | -0.19 <sup>+</sup> | -0.21 <sup>+</sup> | -0.02              | -0.01              | -0.36**            | 0.06              | --                 | --                 |
| Unemployment                             | 0.01               | 0.02              | -0.03*             | -0.01              | -0.03              | -0.00              | -0.03**            | -0.00              | -0.00             | 0.00               | 0.01               |
| Inflation                                | -0.19              | 0.07              | 0.03               | -0.26              | 0.76               | 0.39 <sup>+</sup>  | 0.26               | -0.12              | 0.01              | -0.40 <sup>+</sup> | -1.6**             |
| High negative                            |                    |                   |                    | Neutral            |                    |                    |                    | High positive      |                   |                    |                    |

Significance levels: \* 10%, \*\* 5%, \*\*\* 1%

Notes: for the correct inference of estimated dummy variables parameters, we estimate the system without robust correction of the corresponding standard errors. To distinguish between highly insignificant parameter estimates and estimates for which t-ratios are higher than 1, we denote the corresponding estimated parameters with <sup>+</sup> that corresponds to 32% significance level. The dummy for Slovakia coincides with the global financial crisis, hence the euro corresponding events and crisis event could not be separated. For controls with many missing observations, parameters are denoted with --. For notations of dummy variables see Appendix 1.

The results of this expanded model are shown in Tables 4 (the conditional mean) and 5 (conditional volatility) for the founding members of the euro. As can be seen in the respective Panel A of each Table, news regarding the introduction of euro had diverse impacts on the founding members' stock markets. The estimates of both conditional mean and variance equations for Germany, France, and Italy (i.e. the drivers of the euro) were unaffected by foreign euro news in both the pre- and post-

crisis periods. Indeed, the founding members, in general, saw no significant effects due to foreign euro news in the pre-crisis period, apart from Portuguese markets apparently enthusiastic about euro adoption in Slovenia. On the other hand, the post-crisis period brought more uncertainty to Portugal's views on euro area expansion, with a decline in expected mean returns in response to Lithuania's euro news. Moreover, our estimates show that Belgium, Ireland, Luxembourg, and the Netherlands welcomed foreign euro news and exhibited significantly decreased volatility in the pre-crisis period, with Spanish markets, in particular, having higher expected returns and less volatility due to Latvia's announced embrace of the euro. Foreign euro news also appeared to bring lower volatility to Belgian and Dutch markets both in pre- and post-crisis periods.

**Table 5: Founding members' market reaction to euro adoption announcement and the euro adoption event, conditional variance equation**

| Country  | AT                  | BE                 | DE                 | ES                | FI                 | FR      | IE                 | IT       | LU       | NL            | PT      |  |
|--|---------------------|--------------------|--------------------|-------------------|--------------------|---------|--------------------|----------|----------|---------------|---------|--|
| <b>Panel A: euro announcement events</b>       |                     |                    |                    |                   |                    |         |                    |          |          |               |         |  |
| D1news   | -6.30               | -1.38              | 0.27               | 4.89 <sup>+</sup> | 0.98               | -0.05   | -3.05              |          |          | -0.57         | 2.86    |  |
| D2news   | 1.71                | 0.78               | 0.61               | 1.13              | 1.05               | 0.58*   | 10.66 <sup>+</sup> |          |          | -0.99         | 8.47*   |  |
| Dnews.gr                                       | -2.67               | 0.45               | -0.02              | -0.41             | 0.44               | -0.13   | -0.03              | -1.04    | 2.88     | -1.89         | -2.58   |  |
| Dnews.si                                       | -9.89 <sup>+</sup>  | -3.64**            | -1.47 <sup>+</sup> | -1.88             | -5.19              | -0.28   | -7.8***            | -2.03    | -8.58*   | -3.99**       | -2.34   |  |
| Dnews.mt.cy                                    | -7.87               | -1.83              | 0.05               | -0.82             | 6.67               | -0.01   | 13.49              | 0.09     | -5.54    | 2.32          | 1.98    |  |
| Dnews.sk                                       | 37.67               | 1.49               | -0.13              | 0.78              | 2.93               | 0.91    | 25.17 <sup>+</sup> | -2.04    | 31.43*   | 9.72          | 3.75    |  |
| Dnews.ee                                       | -10.26 <sup>+</sup> | -4.20**            | 1.79 <sup>+</sup>  | 4.27              | -1.88              | -0.45   | -0.70              | -2.08    | -8.17    | -0.16         | -0.57   |  |
| Dnews.lv                                       | -11.89**            | -2.22              | -0.41              | -4.60**           | -5.20              | 0.34    | -2.55              | -0.52    | -7.01    | -3.75***      | -4.74   |  |
| Dnews.lt                                       | -8.45               | -3.50 <sup>+</sup> | -0.32              | -2.15             | -4.27**            | -0.52   | -10.02             | -2.17    | -7.16    | -2.81***      | -0.17   |  |
| <b>Panel B: euro introduction events</b>       |                     |                    |                    |                   |                    |         |                    |          |          |               |         |  |
| Deuro  | 6.58                | 2.16               | -0.10              | 0.06              | 1.35               | -0.25   | 3.60               | 1.40     |          | -0.58         | 1.04    |  |
| Deuro.gr                                       | 31.42 <sup>+</sup>  | 13.77 <sup>+</sup> | -0.10              | -2.42             | 4.37               | -0.33   | 1.41               | -1.32    | 4.69     | 2.44          | -1.90   |  |
| Deuro.si                                       | -8.87 <sup>+</sup>  | -2.74 <sup>+</sup> | -1.30**            | 5.11 <sup>+</sup> | -3.40              | -0.84** | 3.16               | -4.26**  | -6.92*   | -1.27         | -8.70*  |  |
| Deuro.mt.cy                                    | 10.84               | 2.33               | 0.49               | -1.87             | 6.84               | 0.12    | 4.47               | 0.25     | 12.37    | 2.99          | -3.69   |  |
| Deuro.sk                                       | -0.09               | -3.18              | 0.14               | -0.78             | 0.28               | 0.78    | 0.34               | 1.87     | -4.04    | -0.16         | -7.84*  |  |
| Deuro.ee                                       | -10.69*             | -1.47              | -0.16              | -3.35             | 2.22               | 0.74*   | -8.24              | 0.93     | -7.83**  | 0.45          | -10.4** |  |
| Deuro.lv                                       | -12.92 <sup>+</sup> | -1.53              | -0.46              | -2.99*            | -5.42 <sup>+</sup> | -0.10   | 13.55              | -0.25    | -8.70**  | -2.34**       | 6.31    |  |
| Deuro.lt                                       | 6.48                | -2.90*             | -0.20 <sup>+</sup> | -4.18*            | -1.74              | -0.44   | -4.13              | -1.82    | -6.36    | -1.77         | -2.99   |  |
| <b>Panel C: conditional variance variables</b> |                     |                    |                    |                   |                    |         |                    |          |          |               |         |  |
| Constant                                       | 8.16*               | 2.30***            | 0.11               | 0.88              | 0.65               | 0.08    | 0.82               | 0.44     | 2.64***  | 0.68**        | 0.91    |  |
| $\gamma$                                       | 0.98 <sup>+</sup>   | 1.37**             |                    |                   |                    |         |                    |          |          |               |         |  |
| $\alpha$                                       | 0.04                | 0.15**             | 0.04 <sup>+</sup>  | 0.11**            | 0.09**             | 0.04    | 0.05               | 0.10*    | 0.27***  | 0.04          | 0.00    |  |
| $\beta$  | 0.41*               | 0.58***            | 0.92***            | 0.81***           | 0.87***            | 0.89*** | 0.86***            | 0.86***  | 0.63***  | 0.83***       | 0.93*** |  |
| Model  | GJR                 | TARCH              | GARCH              | FS-GARCH          | GARCH              | GARCH   | GARCH              | FS-GARCH | FS-GARCH | FS-GARCH      | GARCH   |  |
|  | High negative       |                    |                    | Neutral           |                    |         |                    |          |          | High positive |         |  |

Significance levels: \* 10%, \*\* 5%, \*\*\* 1%

Notes: The model parameters in Panel A include asymmetry effects ( $\gamma$ ), GARCH effects ( $\beta$ ) and ARCH effects ( $\alpha$ ). See notes on Table 4.

In contrast to the announcements of the euro's introduction, the actual introduction of the common currency had strong effects in Belgium, France, and the Netherlands (see Table 4, Panel B). Even after controlling for additional factors, the negative results for Belgium and the Netherlands are in line with our previous event study findings, while French markets appeared to be enthusiastic about the euro introduction event. The enlargement of the euro area, on the other hand, created little

volatility (Table 5, Panel B), as Austria, Belgium, and the Netherlands had insignificant responses to euro introduction in the pre-crisis period while Germany, France, Italy, Luxembourg, and Portugal saw significant diminishing of volatility accompanying Slovenia's entry. Only Finnish markets seemed skeptical to the euro's introduction in Greece in the pre-crisis period, but a volatility spillover effect is not observed in this market (Table 5).

Our results change noticeably in the post-crisis period, as anticipated in Hypothesis H2. Indeed, euro introduction events in Estonia depressed market returns in Germany, Spain, Luxembourg, and the Netherlands. However, with the exception of France and Estonia, the spread of the euro actually saw decreases in volatility in most countries; this partially confirms the "heat wave" hypothesis, which argues that market volatility is a local phenomenon and does not spread with the euro adoption event in the other market. But the "meteor shower" in the case of the euro's spread may have an unanticipated effect, in that the shower is cooling (in terms of volatility) rather than adding heat. Indeed, this result, of asymmetric volatility spillover effects in tandem with foreign euro adoption news, confirms our Hypothesis H3.

Finally, the results presented in Panel C of Table 4 suggest that the addition of these controls can help to explain some of the movement in stock markets in the euro area. In particular, common market spillover effects, defined by the lagged value of the Eurostoxx index, are very strong in all founding members with a significant impact on the conditional mean in all countries (varying from 0.68 to 1.07). On the other hand, monthly changes in narrow money were significant in only Italian and Belgian stock markets; similarly, country-level developments in domestic labor markets and rising inflation were limited in significance to Portugal, the Netherlands, Italy, and Germany. In terms of behavioral effect, Luxembourgish, Finish, and Irish traders have the least correlation with the ESI variables, while southern countries (Spain, France, Italy, and Portugal) are more responsive to ESI in the euro area. This is in line with strong sentiment effects found in Spanish and French stock markets by Corredor *et al.* (2013). The results in Panel C also suggest that mostly autoregressive (inertial) or GARCH effects are dominant in the models for founding members, while ARCH effects are relatively small and often insignificant.

#### 4.2.2 *Non-Founding Members*

Having a long history of euro area membership, we anticipated that the founding members were expected to respond more to the enlargement of the euro area with asymmetric impacts on their stock markets (Hypothesis H3). It is not as evident that the eight non-founding euro area members, having a much shorter span of membership, would also have such effects, but testing this proposition is the purpose of this section (results summarized in Tables 6 and 7).

**Table 6: Non-Founding members' market reaction to euro adoption announcement and the euro adoption event, conditional mean equation**

| Country                                  | GR       | SI                 | CY                  | MT                 | EE      | LV                 | LT                 |  |
|--|----------|--------------------|---------------------|--------------------|---------|--------------------|--------------------|--|
| <b>Panel A: euro announcement events</b> |          |                    |                     |                    |         |                    |                    |  |
| Dnews.gr                                 | -13.69*  |                    |                     |                    |         |                    |                    |  |
| Dnews.si                                 | 1.01     | -3.80              |                     |                    |         |                    |                    |  |
| Dnews.mt.cy                              | 2.03     | -8.18 <sup>+</sup> | 0.61                | -3.88              |         |                    |                    |  |
| Dnews.sk                                 | -2.11    | 2.07               | 13.87 <sup>+</sup>  | -5.92 <sup>+</sup> |         |                    |                    |  |
| Dnews.ee                                 | 6.28     | -3.93              | -3.76               | -3.01              | 3.90    |                    |                    |  |
| Dnews.lv                                 | 4.74     | --                 | -7.99               | -2.08              | -6.38   | -4.22              |                    |  |
| Dnews.lt                                 | -1.10    | --                 | 6.19                | 0.87               | -2.02   | -3.14              | -0.11              |  |
| <b>Panel B: euro introduction events</b> |          |                    |                     |                    |         |                    |                    |  |
| Deuro.gr                                 | -3.83    |                    |                     |                    |         |                    |                    |  |
| Deuro.si                                 | 6.42     | 14.11***           |                     |                    |         |                    |                    |  |
| Deuro.mt.cy                              | -2.67    | -8.18 <sup>+</sup> | 1.04                | -1.20              |         |                    |                    |  |
| Deuro.sk                                 | -2.11    | 8.92 <sup>+</sup>  | 11.87               | -3.33              |         |                    |                    |  |
| Deuro.ee                                 | 5.08     | --                 | 10.08               | 0.63               | -0.06   |                    |                    |  |
| Deuro.lv                                 | 0.56     | --                 | -0.20               | -2.58              | -2.29   | 4.86               |                    |  |
| Deuro.lt                                 | -18.6*** | --                 | -16.40 <sup>+</sup> | -1.55              | 4.93    | 1.52               | -1.47              |  |
| <b>Panel C: control variables</b>        |          |                    |                     |                    |         |                    |                    |  |
| Constant                                 | 0.15     | 0.13               | -1.66               | 0.41               | 0.87    | 1.06               | 0.75               |  |
| Market spillover                         | 0.97***  | 0.09               | 1.29***             | 0.18***            | 0.41*** | 0.22**             | 0.27***            |  |
| ESI, EA                                  | -1.61*   | -0.62              | -2.22 <sup>+</sup>  | -0.07              | -0.07   | 0.70               | 0.21               |  |
| ESI, EU                                  | 1.61*    | 1.33*              | 3.35*               | 0.39               | 0.72    | -0.15              | 0.93 <sup>+</sup>  |  |
| M1                                       | -0.51    | 0.06               | -0.38               | 0.48               | 0.37    | 0.11               | 0.32               |  |
| <b>Country-level controls</b>            |          |                    |                     |                    |         |                    |                    |  |
| ESI                                      | 0.51**   | 0.25*              | 0.02                | 0.06               | 0.55**  | 0.54*              | 0.17               |  |
| Industrial production                    | -0.32*   | 0.26 <sup>+</sup>  | 0.88 <sup>+</sup>   | -0.09              | 0.52*** | 0.24 <sup>+</sup>  | 0.11 <sup>+</sup>  |  |
| Unemployment                             | -0.04**  | -0.04 <sup>+</sup> | -0.07 <sup>+</sup>  | -0.00              | -0.00   | 0.00               | -0.02 <sup>+</sup> |  |
| Inflation                                | -0.76*   | 0.77               | -0.54               | -0.28              | -1.04   | -1.27 <sup>+</sup> | -0.48              |  |
| High negative                            |          | Neutral            |                     |                    |         | High positive      |                    |  |

Significance levels: \* 10%, \*\* 5%, \*\*\* 1%

Notes: see notes on Table 4. Slovakia is not presented in the rest of the analysis due to many missing observations in the data.

**Table 7: Non-Founding members' market reaction to euro adoption announcement and the euro adoption event, conditional variance equation**

| Country  | GR                | SI                 | CY                  | MT                 | EE                  | LV            | LT       |  |
|--|-------------------|--------------------|---------------------|--------------------|---------------------|---------------|----------|--|
| <b>Panel A: euro announcement events</b>       |                   |                    |                     |                    |                     |               |          |  |
| Dnews.gr                                       | 0.67              |                    |                     |                    |                     |               |          |  |
| Dnews.si                                       | -3.06             | -13.83***          |                     |                    |                     |               |          |  |
| Dnews.mt.cy                                    | -1.74             | 22.09              | -27.69              | -10.76***          |                     |               |          |  |
| Dnews.sk                                       | 3.43              | 27.58              | -15.91              | -0.74              |                     |               |          |  |
| Dnews.ee                                       | -0.81             | 0.16               | -59.36 <sup>+</sup> | -5.44              | -9.25               |               |          |  |
| Dnews.lv                                       | -0.58             | --                 | -1.80               | -7.10*             | -15.34 <sup>+</sup> | -23.39        |          |  |
| Dnews.lt                                       | 1.20              | --                 | 14.73               | -1.96              | -19.98**            | -32.26***     | -11.03*  |  |
| <b>Panel B: euro introduction events</b>       |                   |                    |                     |                    |                     |               |          |  |
| Deuro.gr                                       | -0.83             |                    |                     |                    |                     |               |          |  |
| Deuro.si                                       | -2.54             | 16.23              |                     |                    |                     |               |          |  |
| Deuro.mt.cy                                    | 0.13              | 33.22 <sup>+</sup> | -35.52              | -5.89*             |                     |               |          |  |
| Deuro.sk                                       | 0.03              | -17.70**           | 75.96*              | 13.17              |                     |               |          |  |
| Deuro.ee                                       | 0.17              | --                 | -27.50              | 1.95               | -13.66              |               |          |  |
| Deuro.lv                                       | -0.17             | --                 | 47.96*              | -3.98              | -14.71 <sup>+</sup> | 23.51*        |          |  |
| Deuro.lt                                       | 0.80              | --                 | -24.61*             | 14.42              | -17.68*             | -17.38*       | -10.92*  |  |
| <b>Panel C: conditional variance variables</b> |                   |                    |                     |                    |                     |               |          |  |
| Constant                                       | 1.21              | 5.44*              | 46.88*              | 6.56***            | 11.34               | 4.67          | 0.44     |  |
| $\gamma$                                       | 0.09 <sup>+</sup> |                    | 0.22 <sup>+</sup>   | -1.10 <sup>+</sup> |                     |               |          |  |
| $\alpha$                                       | 0.08              | -0.06              | 0.20*               | 0.15 <sup>+</sup>  | 0.38***             | 0.13**        | 0.12***  |  |
| $\beta$  | 0.90***           | 0.78***            | 0.61***             | 0.40**             | 0.38**              | 0.83***       | 0.90***  |  |
| Model  | TARCH             | TS-GARCH           | TARCH               | TARCH              | TS-GARCH            | TS-GARCH      | TS-GARCH |  |
| High negative                                  |                   | Neutral            |                     |                    |                     | High positive |          |  |

Significance levels: \* 10%, \*\* 5%, \*\*\* 1%

Notes: see notes on Table 5.

The results reported in Table 6 (Panel A) show no return mean dependence on euro adoption news in non-founding members, which could be explained by the low interdependence of these markets with each other. The insignificant reactions of non-founding members to local euro adoption news both in pre-crisis and post-crisis periods are consistent with the event study results (Table 2) in most of the cases, except for Greece, which demonstrates a negative response to euro news after controlling for behavioral effects, implying a strong asymmetric response of Greek traders to additional euro area members. Volatility spillover effects are not observed in Greece and Cyprus in relation to euro adoption news, but a decrease of volatility can be seen in foreign euro introduction news for non-founding members similar as for founding members, both in the pre-crisis and post-crisis periods. The calming “meteor shower” behavior is observed locally for the tightly interrelated stock markets of the Baltic States, as the response to Lithuania the last of the three countries to join the euro area, while the rest of the cases are more in favor of local impacts.

The results reported in Panel B of Tables 6 and 7 show no return mean dependence of financial markets of non-founding members on the actual euro adoption event in non-founding members. Only Slovenia exhibits an economically significant reaction to the local euro adoption event, which comports with the results discussed in the event study (see in Table 2). Greek markets appear to demonstrate a eurosceptic response to euro adoption in Lithuania, reflecting prolonged economic difficulties and the risks associated with a possible Greek exit from the euro both before and during the Lithuanian adoption of the common currency. At the same time, Greek traders appeared to care less about the risks of other new entrants of the euro area, as volatility remained unresponsive to the events in both the pre-crisis and post-crisis period (in line with the “heat wave” hypothesis). The volatility model also fails to capture significant responses in Malta and Cyprus, a divergence from the event study approach. In fact, the findings indicate the sensitivity of results in some markets to the inclusion of additional controls: strong spillover effects are observed for all non-founding members except Slovenia, while later entrants of the euro area are more responsive to EU economic sentiment index and half of them are positively related to local sentiments. This fact which actually helps us to explain the abnormal effects detected in the event study while illustrating that other factors than the euro are at play. Finally, the local calming spillover effects as the result of euro adoption in Lithuania are again observed in the responses of the Baltic States, which all joined in the post-crisis period.

In sum, our findings confirm asymmetric and diverse responses of existing member countries depending on which country is joining. But the “meteor shower” has a cooling down effect on volatility for highly interrelated markets such as the Baltic States or, as seen in the Slovenian case, with founding members in the pre-crisis period.

## 5. Conclusions

Although euro adoption is one of the most important events in European financial history, the euro adoption announcement and event effects are largely unexplored in the literature. Our paper extended Green and Bai (2008) to examine the effects of both euro adoption news and the actual introduction of the euro in founding and non-founding members. Our results are somewhat surprising but characterized by highly heterogeneous responses, dependent upon the country joining the euro and the country stock market of interest. In particular, the event study findings confirmed Green and Bai's (2008) argument that the euro adoption was a well-known and scheduled event of the third stage the EMU with low uncertainty about conditions of the euro accession. However, our results vary from this earlier work, as non-founding members, with less information on euro area effects, had substantial changes in their returns, albeit only in the pre-crisis period.

Heterogeneity also plagued our hypothesis regarding asymmetric responses to euro introduction pre- and post-crisis, as the pre-crisis period showed the little-to-no response of local markets to the news on the adoption of the euro. In the post-crisis period, news of euro introduction had a strong impact in Lithuania, but the introduction of the euro had little effect, suggesting that the political worries surrounding the euro dissipated when financial markets saw the economic benefits.

Perhaps our most interesting result is that, with regard to spillover effects, founding members, in general, were undisturbed by additional euro introductions pre-crisis but actually saw decreased volatility in the post-crisis period from additional members. For the non-founding members, in general, there also was a reduction in volatility both in the pre-crisis and post-crisis periods. The "meteor shower" and "heat wave" hypotheses developed in Engle *et al.* (1990) are useful in explaining our results, which confirm asymmetric and diverse responses of existing member countries depending on which country is joining. However, as demonstrated, the "meteor shower" of the euro appeared to be a cool shower rather than a hot one, lessening volatility across borders.

The implications of this finding call for more investigation into the political economy of euro expansion; for example, the relief felt by the markets of founding members when new entrants joined in the post-crisis period could have been related to a renewed faith in the currency's viability. Similarly, the dampened volatility in the new members may have been predicated on purely internal conditions and the next crisis may change their response to additional entrants. This paper has made a modest contribution to understanding the actual responses of financial markets to the euro, but more work is called for in understanding the circumstances behind these responses.

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## Appendix 1. Country notations and euro events dates.

| Country code, CC | Country     | Euro introduction news 1 stage for 11 founding members, D1news | Euro introduction news 2 stage for 11 founding members. D2news | Euro adoption news, Dnews.CC | Euro introduction date, Deuro Euro adoption date, Deuro.CC |
|------------------|-------------|--|--|------------------------------|--|
| AT               | Austria     | 17.06.1997   | 05.03.1998   |                              | 01.01.1999   |
| BE               | Belgium     | 17.06.1997   | 05.03.1998   |                              | 01.01.1999   |
| DE               | Germany     | 17.06.1997   | 05.03.1998   |                              | 01.01.1999   |
| ES               | Spain       | 17.06.1997   | 05.03.1998   |                              | 01.01.1999   |
| FI               | Finland     | 17.06.1997   | 05.03.1998   |                              | 01.01.1999   |
| FR               | France      | 17.06.1997   | 05.03.1998   |                              | 01.01.1999   |
| IE               | Ireland     | 17.06.1997   | 05.03.1998   |                              | 01.01.1999   |
| IT               | Italy       | 17.06.1997   | 05.03.1998   |                              | 01.01.1999   |
| LU               | Luxemburg   | 17.06.1997   | 05.03.1998   |                              | 01.01.1999   |
| NE               | Netherlands | 17.06.1997   | 05.03.1998   |                              | 01.01.1999   |
| PT               | Portugal    | 17.06.1997   | 05.03.1998   |                              | 01.01.1999   |
| GR               | Greece      |  |  | 20.06.2000                   | 01.01.2001   |
| SI               | Slovenia    |  |  | 03.02.2006                   | 01.01.2007   |
| MT               | Malta       |  |  | 16.05.2007                   | 01.01.2008   |
| CY               | Cyprus      |  |  | 16.05.2007                   | 01.01.2008   |
| SK               | Slovakia    |  |  | 05.07.2008                   | 01.01.2009   |
| EE               | Estonia     |  |  | 07.03.2010                   | 01.01.2011   |
| LV               | Latvia      |  |  | 07.09.2013                   | 01.01.2014   |
| LT               | Lithuania   |  |  | 23.07.2014                   | 01.01.2015   |

## Appendix 2. Descriptive statistics, daily stock market returns.

| i  | Mean    | Median  | Minimum | Maximum | Std. Dev. | Skewness | Ex. kurtosis |
|----|---------|---------|---------|---------|-----------|----------|--------------|
| AT | -0.0001 | 0.0010  | -0.0870 | 0.0526  | 0.0131    | -1.0055  | 5.2157       |
| BE | 0.0010  | 0.0014  | -0.0448 | 0.0445  | 0.0108    | -0.1380  | 1.6869       |
| DE | 0.0011  | 0.0024  | -0.0838 | 0.0611  | 0.0157    | -0.7546  | 3.0796       |
| ES | 0.0013  | 0.0017  | -0.0672 | 0.0573  | 0.0145    | -0.5375  | 3.4616       |
| FI | 0.0016  | 0.0030  | -0.0859 | 0.0970  | 0.0168    | -0.4523  | 4.5643       |
| FR | 0.0011  | 0.0012  | -0.0563 | 0.0610  | 0.0143    | -0.2103  | 1.9921       |
| IE | 0.0011  | 0.0015  | -0.0757 | 0.0583  | 0.0111    | -0.6399  | 7.0860       |
| IT | 0.0014  | 0.0030  | -0.0636 | 0.0699  | 0.0211    | -0.1876  | 0.6666       |
| LU | -0.0010 | -0.0015 | -0.0179 | 0.0120  | 0.0075    | -0.1225  | -0.3366      |
| NE | 0.0011  | 0.0022  | -0.0612 | 0.0573  | 0.0155    | -0.3819  | 1.8605       |
| PT | 0.0015  | 0.0016  | -0.0959 | 0.0694  | 0.0138    | -0.8879  | 7.9272       |
| GR | -0.0005 | -0.0014 | -0.0962 | 0.0762  | 0.0211    | 0.1359   | 2.0605       |
| SI | 0.0009  | 0.0004  | -0.0635 | 0.0556  | 0.0090    | -0.3267  | 7.8483       |
| MT | -0.0004 | -0.0003 | -0.0297 | 0.0345  | 0.0067    | 0.0508   | 4.6162       |
| CY | 0.0007  | 0.0006  | -0.0885 | 0.0836  | 0.0171    | -0.3182  | 3.8057       |
| SK | -0.0032 | 0.0003  | -0.3298 | 0.2843  | 0.0554    | -0.7587  | 17.4090      |
| EE | 0.0023  | 0.0014  | -0.0575 | 0.1209  | 0.0154    | 1.3192   | 8.1301       |
| LV | 0.0007  | 0.0005  | -0.0358 | 0.0329  | 0.0079    | -0.1724  | 1.4701       |
| LT | 0.0003  | 0.0002  | -0.0384 | 0.0291  | 0.0055    | -0.6139  | 10.1050      |

Notes: summary statistics are provided for samples, where event studies models were estimated, and vary from 1.5 to 2.5 years depending on the country case. Negative values for skewness show that market returns below the median are typically larger in magnitude than above median. High values for excess kurtosis mean that outliers are more likely than for normal distribution.

### Appendix 3. Descriptive statistics, monthly stock market returns.

| i  | Mean    | Median  | Minimum  | Maximum | Std. Dev. | Skewness | Ex. kurtosis |
|----|---------|---------|----------|---------|-----------|----------|--------------|
| AT | 0.3640  | 1.0430  | -32.5940 | 13.5470 | 6.2709    | -1.3110  | 4.2949       |
| BE | 0.3437  | 1.0735  | -24.0880 | 13.5140 | 5.0667    | -1.3646  | 3.6102       |
| DE | 0.6860  | 1.4967  | -29.3330 | 19.3740 | 6.4787    | -0.9347  | 2.7507       |
| ES | 0.5494  | 0.9654  | -21.5140 | 15.1910 | 5.9657    | -0.5364  | 1.0458       |
| FI | 0.7121  | 1.2344  | -31.3220 | 25.7510 | 7.7692    | -0.3363  | 2.0468       |
| FR | 0.3968  | 1.2334  | -19.2250 | 12.5880 | 5.5443    | -0.6019  | 0.5755       |
| IE | 0.4119  | 1.2670  | -23.5820 | 17.8250 | 5.8565    | -0.9685  | 2.0317       |
| IT | -0.0253 | 0.4565  | -18.3080 | 19.0890 | 6.4861    | -0.2349  | 0.6804       |
| LU | 0.2866  | 1.0579  | -31.2050 | 16.6460 | 6.7946    | -1.3198  | 4.4766       |
| NE | 0.3313  | 1.2182  | -22.6220 | 14.5690 | 5.9745    | -1.0148  | 2.2119       |
| PT | 0.1450  | 0.5363  | -23.3480 | 17.1920 | 6.0838    | -0.4948  | 1.3605       |
| GR | -0.1060 | 0.2222  | -32.6730 | 34.5950 | 9.5172    | -0.1528  | 1.2152       |
| SI | 0.4759  | 0.4487  | -20.6910 | 28.4990 | 6.6009    | 0.0366   | 2.5628       |
| MT | 0.5790  | -0.0778 | -10.8300 | 22.6780 | 4.9457    | 1.1539   | 3.1253       |
| CY | -2.2187 | -1.0982 | -53.4420 | 38.0550 | 14.7600   | -0.3360  | 1.0556       |
| SK | -0.3921 | -0.0557 | -36.1010 | 22.6770 | 7.6009    | -1.2778  | 7.2628       |
| EE | 0.9862  | 1.1147  | -44.9770 | 37.0330 | 9.8791    | -0.6968  | 4.7779       |
| LV | 0.7323  | 0.6294  | -27.0750 | 29.2340 | 6.7212    | -0.3394  | 4.3035       |
| LT | 0.8654  | 0.9356  | -35.0910 | 36.0760 | 7.2522    | -0.4754  | 6.5816       |

Notes: summary statistics are provided for the whole available data samples. Values for logarithmic returns are multiplied by factor 100, hence could be interpreted as percentage changes. Negative values for skewness show that market returns below the median are typically larger in magnitude than above median. High values for excess kurtosis mean that outliers are more likely than for normal distribution.

### Appendix 4. Descriptive statistics, monthly stock market volatility.

| i  | Mean     | Median  | Minimum | Maximum   | Std. Dev. | Skewness | Ex. kurtosis |
|----|----------|---------|---------|-----------|-----------|----------|--------------|
| AT | 41.7910  | 12.8710 | 0.0000  | 901.1200  | 91.2860   | 5.2483   | 37.4290      |
| BE | 39.1540  | 10.1950 | 0.0003  | 1086.2000 | 98.4490   | 7.1986   | 64.9380      |
| DE | 25.5600  | 7.9046  | 0.0001  | 596.9000  | 60.6720   | 5.6954   | 40.7510      |
| ES | 35.4350  | 9.6524  | 0.0002  | 486.8000  | 61.9760   | 3.4145   | 15.8810      |
| FI | 60.0970  | 17.3860 | 0.0000  | 1026.2000 | 121.1600  | 4.0984   | 21.7180      |
| FR | 30.6060  | 11.6380 | 0.0013  | 385.0300  | 49.2250   | 3.1924   | 13.8880      |
| IE | 34.1500  | 11.0850 | 0.0041  | 575.7200  | 68.7200   | 4.1738   | 21.6700      |
| IT | 41.8670  | 14.7650 | 0.0000  | 365.3400  | 68.7100   | 2.8116   | 8.2497       |
| LU | 45.9280  | 11.7390 | 0.0001  | 991.6900  | 117.1900  | 5.8398   | 38.7060      |
| NE | 35.5390  | 9.9070  | 0.0017  | 526.8400  | 73.0970   | 4.2732   | 21.6610      |
| PT | 36.8510  | 12.7150 | 0.0007  | 551.9100  | 67.7020   | 3.9073   | 19.3220      |
| GR | 90.1840  | 27.0310 | 0.0000  | 1204.1000 | 162.0600  | 3.7301   | 17.5370      |
| SI | 43.3260  | 10.3770 | 0.0007  | 785.3000  | 92.8100   | 4.4919   | 26.0970      |
| MT | 24.3540  | 6.3467  | 0.0000  | 488.3800  | 55.2560   | 5.5906   | 39.6710      |
| CY | 216.1400 | 55.7580 | 0.0076  | 2623.8000 | 379.3200  | 3.3106   | 14.1600      |
| SK | 57.1600  | 2.6180  | 0.0023  | 1275.1000 | 174.9000  | 4.8602   | 27.0510      |
| EE | 97.1630  | 19.3900 | 0.0005  | 2112.6000 | 253.5200  | 4.9254   | 27.6710      |
| LV | 44.9270  | 9.5811  | 0.0010  | 812.3400  | 113.1100  | 4.9381   | 27.4810      |
| LT | 52.3050  | 10.7550 | 0.0000  | 1292.9000 | 153.6500  | 6.3459   | 44.4130      |

Notes: see appendix 3. Volatility is defined as zero-mean squares of monthly logarithmic returns.