European bank equity risk: 1995-2006

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Abstract

We examine changes in bank equity risk following the formation of the Economic Monetary Union (EMU) in 1999. With the exception of Germany, we observe a decline in bank risk across euro-zone countries. Total risk decreased for 70% of the euro-zone banks in our sample with a statistically significant decrease in total risk observed for 51% of the sample. Similar results are found for idiosyncratic risk and systematic risk. These results are robust to financial crisis effects and test specification. Moreover, we find some evidence of a decrease in bank equity risk for a sample of neighbouring non-euro-zone European countries, consistent with the existence of some spill-over effects.

JEL Classification : G2; G32

Keywords: Economic Monetary Union (EMU); Banks; Euro-zone; Total risk; Systematic risk; Idiosyncratic risk

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1. Introduction

This paper provides an empirical analysis of the impact on bank equity risk of Economic Monetary Union (EMU) and the accompanying deregulation and integration. The literature dealing with European banks provides little guidance concerning the impact of EMU on listed banks yet some fundamental economic changes accompanied EMU (Allen and Song, 2005). In particular, they find that euro-zone banks, compared with banks in Asia or the USA, exhibit greater levels of financial integration with the formation of EMU.

It is important to analyse the impact of EMU on bank equity risk because the banks play a key role in the allocation of resources, mobilisation of savings, diversification of risk. These institutions have an important impact on the profitability of investment and productivity of an economy (Francis and Hunter, 2004). Further, financial intermediaries such as banks are a major part of an economy in their own right. They influence the securities markets and promote economic growth by providing liquid financial markets. Banks also encourage diversification and specialization (Diamond and Dybvig, 1983). Further, change in bank equity risk with the EMU is important because changes in equity risk can have repercussions for investors, borrowers and regulators. While decreases in the systematic risk of equity may be associated with increased market value, an increase in idiosyncratic equity risk is also of importance to regulators who are very much concerned with the performance of individual banks.

The bank deregulation literature generally deals with USA banks and while it is found that deregulation can result in increased bank risk it can also foster better risk management (Houston and Stiroh 2006). Certainly, one objective of the EMU is to achieve greater levels of competition and it has been argued that a consequence of increased competition is increased bank risk as banks seek out more risky high yielding investments in order to maintain profit

margins (Bundt, Cosimano and Halloran, 1992, Park, 1994 and Galloway, Lee and Roden, 1997). Deregulation may also allow banks to diversify and this could result in reduced risks (Craig and Santos, 1997). Thus, the formation of EMU provides an opportunity to study the impact of EMU driven deregulation and economic integration on European bank equity risk.

Our analysis is based on bank share price data collected for all available European banks from Datastream over the period from January 1995 to April 2006. Three measures of equity risk (systematic risk, unsystematic risk and total risk) are estimated for each of the banks. We find bank equity risk generally decreases over the period, a characteristic not evident for the non-financial sector within the euro-zone countries. Further, there is some evidence of spill over effects with neighbouring non-euro-zone banks also exhibiting decreases in risk. Perhaps this is not surprising given the size of the financial markets that fall within the ambit of the EMU. One important exception is the German banking sector where bank risk increases are observed. In the following section we review the literature and develop hypotheses. The data and methodology are described in section 3 with results reported in Section 4. Results from robustness tests are reported in Section 5 and the key results of the paper are summarised and conclusions reported in Section 6.

2. Literature Review and Hypothesis Development

The establishment of EMU has had a significant impact on the European bank industry in terms of competition and consolidation (Francis and Hunter, 2004 and Altunbas and Ibanez, 2004). The development of this new financial system with the introduction of the European Central bank (ECB) and Euro-bond market, along with the steps taken to harmonize and assimilate the securities markets, has given the banking system more opportunity to access funds.

Yet, there has been little change in the euro-zone banking legislation over the period of the study as much of the critical regulation was in place by 1992. The banking industry is often considered to be one of the more regulated industries with the impact of the Basel Accord, adopted in 1988 and designed to monitor bank risk exposures (Francis and Hunter, 2004) and the more recent European Union (EU) Bank Directives. While recent European bank crises have led banking regulators to be more cognisant of bank risk taking activity, it has been argued that the liberalization of the European banking industry via the abolition of interest rate restrictions, credit controls and barriers to entry (Francis and Hunter, 2004) may have allowed European banks to better deal with greater levels of competition and financial crises. Further, the formation of EMU may also have had a spill-over effect onto neighbouring non-euro-zone European countries. It is evident that the financial institution consolidation that has occurred with EMU has also played an important role in financial integration between euro-zone and non-euro-zone countries and contributed to the integration of European financial markets more generally (Allen and Song, 2005).

The effect of EMU on the health of the European banking sector remains an important concern. Yet, the European banking literature offers little guidance as to the impact of EMU on the European bank equity risk. It is also important to note the increase in equity market co-movement observed between euro-zone countries and neighbouring non-euro-zone countries (Allen and Song, 2005 and Bartram, Taylor, Wang, 2007).

We also note the recent takeover waves that have occurred in Europe with the formation of the EMU, particularly the dramatic increase in merger and acquisition activity from 1998 onwards. While it is possible that some common factor is responsible for both the change attributed to EMU and the observed increase in takeovers that has occurred with EMU this seems

unlikely.[1] Euro-zone bank consolidations have been quite profitable for the acquiring banks, particularly cross-border acquisitions, which have been simplified with EMU (Altunbas and Ibanez, 2004). Bank consolidation has also had a dramatic impact on the banking systems of a number of the individual euro-zone countries. For example, Staikouras and Koustsomanoli-Fillipaki (2006) report a 17% reduction in the number of credit institutions for the EU-15 group of nations over the period 1998 to 2002.[2] Bank consolidation can lead to diversification, particularly with cross border acquisitions, and it is often argued that more extensive bank branching can result in reduced bank risk (Craig and Santos, 1997). In particular, Marco and Robles-Fernandez, (2007) provide evidence to support the argument that increased diversification led large Spanish commercial banks to lower their risk level.

Core objectives of the formation of EMU include increased competition and integration yet the greater competition arising from financial deregulation and integration may affect bank incentives for prudent risk taking. In this respect, Boyd and De Nicolo (2005) argue excessive competition leads to socially undesirable events such as bank runs, panics and, possibly bank crises leading to overall financial instability (Salas and Saurina, 2003, Galloway, Lee and Roden, 1997, Park, 1994 and Bundt, Cosimano and Halloran, 1992). These studies propose that increased competition increases bank costs and decreases bank income which encourages banks to undertake high risk, high yield projects in an effort to recover lost profit margin. However, it has been argued that deregulation of the US bank industry not only generated opportunities to increase risk but it also equipped the banks to control, share and manage risk (Houston and Stiroh 2006).

[1] The need to maintain bank franchise value could provide an alternative explanation for mergers and acquisitions. We would like to thank the referee for indicating this issue to us.

[2] While an increase in the number of credit institutions of 3.4% is reported for Greece, there was a 27% decrease in the number of credit institutions in Germany over the same period.

Further, diversification arguments generally predict that bank risk decreases. Baele, De Jonghe and Vennet (2007), on European banks, show a non linear relationship between total risk and diversification though most European banks confirm that diversification can decrease total risk. In contrast, Demsetz and Strahan (1997) propose that despite large US bank holding companies being better diversified (than small ones) this does not necessarily lower their risk level. Hughes, Lang, Mester and Moon (1996) observe that increased diversification (geographic and/or depositor diversification), while correlated with decreases in the price of risk, may motivate US bank holding companies to undertake greater levels of risk to increase their returns. This leads to the total risk hypothesis with the prediction of either increased risk with greater competition and integration (Boyd and De Nicolo, 2005) or decreased risk with diversification (Craig and Santos, 1997).

Null hypothesis: No change in total bank equity risk
Alternate hypotheses: Total bank equity risk (increases) decreases with EMU

Changes in total bank equity risk may be either due to changes in systematic or idiosyncratic risks. Therefore, it is also important to look into how systematic and idiosyncratic changes in the post-EMU period. With regard to idiosyncratic risk, it is possible that idiosyncratic risk may increase with the formation of the EMU. This could arise from diversification of bank activities and increased competition. With greater competition, banks may choose to increase leverage to increase profits but this will also increase idiosyncratic risk because the shareholders bear a greater share of cash flow risk of the firm (Campbell, Lettau, Malkiel and Xu 2001) [3]. Moreover, financial innovation linked to EMU may increase idiosyncratic risk (Stein 1987). It is also likely that derivative instruments could also increase

[3] However, Campbell, Lettau, Malkiel and Xu (2001) find during 1990s the decrease in US corporate leverage led to an increase in idiosyncratic risk.

bank idiosyncratic risk where troubled banks facing greater competition use derivatives to bolster profits but at the cost of increase bank risk (Dewatripont and Tirole 1995).

Yet, Altunbas and Ibanez (2004) suggest that large efficient European banks have tended to merge with relatively small and well-capitalized banks resulting in more diversified sources of income. This may help the European banks to decrease their idiosyncratic risk. Similarly, Baele, De Jonghe and Vennet (2007) find that most European banks confirm that diversification can actually decrease the bank idiosyncratic risk. Similarly for the US banks, it is evident that revenue diversification and ease of investment opportunities that arise from deregulation reduced the idiosyncratic risk of the US commercial banks after 1998 (Houston and Stiroh 2006). Thus, the formation of EMU has given the European banking industry the opportunity to diversify risk through varying their activities, which may allow banks to reduce their idiosyncratic risk. Again the literature is not clear on the expected change in risk with EMU and we formulate our second hypothesis.

Null hypothesis: No change in bank equity idiosyncratic risk
Alternate hypotheses: Bank equity idiosyncratic risk (increases) decreases with EMU

With regard to systematic risk, we could expect that there will be a decrease in bank systematic risk as European bank concentration increases with increased domestic merger activity following the formation of EMU. It is often argued that domestic mergers lead to increased market concentration through reduced costs, reduction in branch overlap and increased market power. For example, Europe wide branching would lessen the risk of bank failure arising from unfavourable local economic conditions. Moreover, mergers can create an internal money market either through diversification or internationalization that aids banks in dealing with future macroeconomic shocks (Carletti, Hartmann and Spagnolo, 2006). In contrast, Baele, De Jonghe

and Vennet (2007) on European banks show that diversification can increase bank systematic risk. Deregulation (such as the Depository Institutions Deregulatory and Monetary Control Act 1980 introduced in the US) can also benefit bank shareholders resulting in a reduction in the systematic risk (Aharony, Saunders and Swary, 1988). Akihgbe and Whyte (2004) examine the long-term shift in risk after the passage of Gramm-Leach-Bililey Act 1999 in the US. They find that increased financial integration led to a decrease in bank systematic risk. In essence, financial integration can help the banking system to cope with local shocks through diversification (Strahan, 2006).

However, Smirlock (1984), in analysis of the impact of deregulation on US banks, shows that deregulation did not change average bank systematic risk in their samples of banks. Further, it is possible to argue that, bank systematic risk need not decrease with bank concentration. If mergers are cross-border mergers, then banks will spread their activities geographically and as a result banks may be more exposed to Europe wide shocks as distinct from country specific shocks. Furthermore, the easing of barriers to entry and exit and the increased competition that accompanies this may lead to banks investing in riskier projects. Since EMU, a number of investment banks have entered the euro-zone and there has been rapid development of the Euro-bond markets and securities markets. This could lead to increased competition and may threaten future bank profitability. Based on the above discussion we can formulate our third and last of our hypotheses. Again, given the state of the literature we have no prior on the expected change in risk that will accompany EMU.

Null hypothesis: No change in systematic bank equity risk
Alternate hypotheses: Systematic bank equity risk (increases) decreases with EMU

3. Data and method

We use monthly data obtained from Datastream to construct a sample of share returns for 96 euro-zone country banks[4] and 85 non-eurozone European banks[5] spanning the period from January 1995 to April 2006. This includes both the A and B shares for one Finnish bank. Thus, the total number of sample bank shares stands at 181. Our sample includes listed banks of different types such as commercial banks, savings banks and bank holding companies. The sample captures around about 80% to 100% of the banking industry aggregate market value for almost all the countries included in the analysis except for Austria and Norway, where there is some variation in the Datastream coverage of the banking industry over the study period.[6]

We calculate continuously compounded monthly returns for each of the banks and include both delisted and merged banks in our full sample. While some survivorship bias is inevitable with the individual bank based analysis the banking sector portfolios and FTSE banking indices reduces the impact of this problem as they are based on the bank population available at the end of each month though this also clouds much of the interesting individual bank level variation in risk. Euro-zone country bank equity returns are calculated using the Datastream data which is based on the ECU for the pre EMU period and euro for the EMU period. Local currency is used for non euro-zone country bank returns. In addition, we have extracted the MSCI individual country equity market indices, the MSCI Europe equity market

[4] The countries include Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Portugal, the Netherlands and Spain.

[5] The countries include Denmark, Norway, Sweden, Switzerland and United Kingdom.

[6] Our sample follows the Datastream banking index lists fairly closely. These indices are designed to cover around 90% of the aggregate market value of the sector and so this ensures our sample also attains good coverage of the sector aggregate market value for each country. Moreover, the ratio of total assets of the sample banks to the total assets of the individual country financial institutions was calculated for each of the EMU countries in our sample for the years from 1997 to 2006. The average of these ratios was then calculated for each of the countries and these ratios vary considerably from country to country. The total assets of the individual country financial institutions was obtained from the ESCB statistics following Goddard, Molyneux, Wilson and Tavakoli (2007). While we find that some ratios are as low as 20% on average (Austria and Finland), other ratios are considerably higher including France (54%), Greece (65%), the Netherlands (82%), Portugal (41%) and Spain (58%).

index and the MSCI world equity market index from Datastream for estimation of systematic risk and idiosyncratic risk.

The descriptive statistics for the individual European Union based banks included in the study are reported in table 1. The mean monthly return ranges from 1% to 2% per month on average and volatility ranges from 4% to 17% per month. There is some variation in skewness and kurtosis across the countries with the maximum and minimum average monthly returns evident for Finnish banks.

[Insert Table 1 about here]

Our choice of equity risk measure follows the work of Bundt, Cosimano and Halloran (1992) and Smirlock (1984).[7] We use the standard market model to measure systematic risk:

$$\widetilde{R}_{it} = \alpha_i + \beta_i \widetilde{R}_{mt} + \widetilde{\varepsilon}_{it} \qquad (1)$$

where, $\widetilde{R}_{it}$ is the return of individual security at time period t, $\widetilde{R}_{mt}$ is the return on an equity market index at time period t. The systematic risk estimate for each bank or portfolio of banks is captured by β_i (systematic risk) and $\widetilde{\varepsilon}_{it}$ is a random shock term. Following Binder (1985) and Bundt Cosimano and Halloran (1992) we extend the market model in equation (1) by introducing a dummy variable to capture the possibility of a structural change in systematic risk. In our analysis the dummy variable takes on a value of zero (0) for the months of January 1995

[7] In addition, following Kane and Unal (1988), we use long-term government bonds as a proxy for the interest rate and include this variable in the regression model. This alternative model takes the form:

$\widetilde{R}_{it} = \alpha_{pre} + \beta_1 D_t + \beta_2 \widetilde{R}_{mt} + \beta_3 \widetilde{R}_{mt} D_t + \beta_4 I_t + \widetilde{\varepsilon}_{it}$

where, I_t = monthly change in the interest rate on a 10 year government bond and β_2 = pre-euro beta, β_3= changes in systematic risk and β_4 = interest rate risk. Given there is little change in the results using this model we do not report these results separately in this paper.

to December 1998 and a value of one (1) from January 1999 to April 2006.[8] The model is written as:

$$\tilde{R}_{it} = \alpha_{pre} + (\alpha_{post} - \alpha_{pre})D_t + \beta_{pre}\tilde{R}_{mt} + (\beta_{post} - \beta_{pre})\tilde{R}_{mt}D_t + \tilde{\varepsilon}_{it} \quad (2)$$

Where D_t = 0 pre-euro period January 1995 - December 1998 and D_t =1 post -euro January 1999 – April 2006. This model is estimated using individual bank returns as well as the returns from both an equally weighted bank portfolio and a market-value weighted bank portfolio. We also apply equation (2) to FTSE bank indices for each country to assess the robustness of the results, though there is little change.

Total risk of the individual banks, as well as the bank portfolios, is estimated using the following equation:

$$\sigma_{ri}^2 = 1/N \sum_{t=1}^{N} (R_t - \overline{R})^2 \quad (3)$$

where, σ_{ri}^2 is the variance of the return for bank *i*, R_i return of bank *i* and $\overline{R}$ average return of bank *i.*

We measure idiosyncratic risk using the following equation:

$$\sigma^2{}_{ri} = \beta^2 \sigma_{rm}^2 + \sigma_{\varepsilon}^2 \quad (4)$$

where, σ_{ri}^2 is the total risk or variance of the bank returns for bank *i* , σ_{ε}^2 is the idiosyncratic risk of the bank returns and $\beta^2 \sigma_{rm}^2$ is the systematic risk of individual banks and bank portfolios. We rearrange equation (4) to estimate the idiosyncratic risk (Bundt, Cosimano and Halloran, 1992) for individual banks as well as the equally weighted and the market value weighted bank portfolios and the FTSE indices.

[8] One exception is Greece where we use January 1995- December 2000 as the pre euro period and January 2001 – April 2006 as the post euro period.

$$\sigma_{\varepsilon}^{2} = \sigma^{2}_{ri} - \beta^{2}\sigma^{2}_{rm} \quad (5)$$

We report total risk and idiosyncratic risk in terms of standard deviation in our results to simplify interpretation.

4. Results

It is important to first identify whether the changes in risk are economy wide movements or whether these shifts in risk are more localised. We estimate total risk, idiosyncratic risk and systematic risk for the European non-financial sector and the European banking sector using equity market indices provided by Datastream. The MSCI European and world indices are used to capture market effects. While changes in risk that occur with EMU are not generally statistically significant at this very broad European economy level we note in Table 2 that banking sector risk generally falls while non-financial sector risk generally rises.[9]

[Insert Table 2 about here]

Given our interest in the euro-zone banks we narrow this analysis further, comparing the euro-zone banking sector with the non-financial sector for each of the countries, Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain. As can be seen from the counts that are reported in table 2 for the MSCI European index based calculations, a majority of the country bank sectors exhibit decreased risk with EMU, while increases and decreases are fairly evenly spread amongst the individual euro-zone country non-financial sectors. For example, if we focus on total risk we observe decreases (increases) in six (five) of the eleven country non-financial sectors with only three of these being statistically significant at the 10% level or better. Yet, we note that for the bank sectors in these countries there are decreases (increases) in seven (four) of the eleven countries and in six of these seven

[9] We thank the reviewer for suggesting that we undertake this higher level analysis.

cases the decline is statistically significant at the 10% level or better. The euro-zone country sector based results suggest that important changes have occurred in the banking sectors of these countries that are not closely reflected in the respective non-financial sectors.

To gain a better idea of the impact of the EMU period at the individual bank level we repeat the analysis using individual bank total risk, idiosyncratic risk and systematic risk and find that these risk measures have also reduced substantially with EMU for a majority of the euro-zone banks in our sample (See Table 3 and 4). Thus, we find support for our three hypotheses and this support is evident at both the individual bank level and the bank sector level (proxied by equally weighted and value weighted portfolios of the banks in our sample[10]). The decrease in risk is particularly evident for Austrian, French, Italian, Greek, Portuguese and Spanish banks (See Tables 3 and 4). From Table 3, Panel A, we note that 67 of the 96 euro zone banks (70% of the sample) exhibit a decline in total risk on average of 19%, with more than half of these declines being statistically significant. Further, bank idiosyncratic risk (Panel B, Table 3) declined 10% on average with 58 of the 96 banks (60% of the sample) exhibiting decreased risk. Further, there was a 19% decrease in systematic risk on average with declines observed in 63 of the banks in the sample (64% of the sample). Regardless of risk measure, almost half of the declines are statistically significant. The sample includes both commercial banks and bank holding companies with the declines evident broadly across the sample. Regardless, there are a few banks, particularly the German banks that show an increase in total risk and idiosyncratic risk in particular.

[Insert Tables 3 and 4 about here]

Given the important links that exist between the euro-zone countries and the neighbouring euro-zone countries we also conduct analysis of the change in risk for banks in the

[10] The results for equally weighted and market value weighted portfolio is not reported but is available upon request.

countries, Denmark, Norway, Sweden, Switzerland and the United Kingdom. We find a general decrease in bank equity risk in Sweden and United Kingdom but an increase in total risk and idiosyncratic risk in Denmark. One possible explanation for this result may be interpreted in terms of the formation of EMU leading to an increase the European financial market integration (Allen and Song, 2005). Furthermore, Europe is fairly unique in terms of the level of bank consolidation that occurred in its banking system during the period from 1999 to 2003, particularly when compared to other regions such as the USA and Asia. Regional integration between euro-zone and non euro-zone European countries may help to explain this effect over the last ten years (Allen and Song, 2005).

We run chi-square tests to test for statistical significance of the proportion of banks with decreases in risk relative to those with increases in risk. Under ordinary circumstances it would be expected that individual bank risk is as likely to rise as it is to fall (null hypothesis) and on the basis of this expectation we construct chi-square tests to test the proportion of banks that exhibit a change in risk with EMU. These tests show that a statistically significant proportion of the euro-zone bank sample exhibited a decrease in total risk (Prob. = 0.00), idiosyncratic risk (Prob. = 0.01) and systematic risk (Prob. = 0.00) with introduction of EMU. This provides further support for our hypotheses with respect to the euro-zone banks. We also performed this test using the neighbouring non euro-zone banks with support only for hypothesis three for the non euro-zone banks.[11] There is a significant proportion of the euro-zone banks with decreased risk, though the decreases in risk are not so widespread in the neighbouring non euro-zone country sample, particularly for total risk and idiosyncratic risk.

[11] Although the chi-square test for systematic risk was statistically significant (Prob. = 0.00), the null could not be rejected for either total risk (Prob. = 0.38) or idiosyncratic risk (Prob. = 0.23).

It is possible that the recent wave of bank mergers and acquisitions (Pricewaterhouse Coopers, 2006) are unrelated to EMU and that the results we observe in this study are due entirely driven by bank consolidations. This argument would certainly find support in the work of Amihud, DeLong and Saunders (2002), who find that cross-border mergers do not increase the risk of either the domestic bank or the host bank. Yet, it is difficult to see how the formation of the EMU and the recent merger and acquisition activity in Europe can be separated. Indeed, Altunbas and Ibanez (2004) state that the mergers and acquisition growth "…increased in parallel with the introduction of the Monetary Union" (p. 7). We do not attempt to disentangle the relationship that might exist between EMU and the recent merger and acquisition activity though we believe that this activity is closely related with EMU in Europe.

5. Robustness

There are number of further tests that have been conducted to assess the robustness of the results reported so far.[12] First, we test for change in risk using sub samples of the original bank sample, particularly commercial banks divided into foreign exposure banks, regional exposure banks and local exposure banks. Second, we analyse the change in systematic risk, idiosyncratic risk and total risk using the MSCI world index and MSCI Europe index for both individual bank and bank portfolios with both single market model and two-factor market models. We also fit the Fama-French three factor model to the data to assess the impact on market risk after adjustment for size and value characteristics of the bank equity returns. Third, we re-estimate systematic risk using dummy variables to adjust for some of the critical events that have occurred during the study period, such as the Asian crisis 1997, the Russian ruble crisis 1998 and the internet bubble 2000. Fourth, we re-estimate all of the country wide results using individual country commercial bank indices. Fifth, we compare the change in risk for banking and non-financial indices. Sixth,

[12] Further details on the robustness of the results are available upon request.

we test to see whether this is a purely euro effect or whether similar changes in bank risk are observed for neighbouring non euro-zone banks. Seventh, we test for the impact of excluding the Italian savings banks from the sample.[13] Eighth, we generate CUSUM square graphs to check the timing of structural breaks to see whether these are aligned with the date when the EMU was put into place. Finally, we test to see whether changes in the level of economic growth could explain the decrease in bank risk.

The results from sensitivity tests, one through eight, are consistent with our primary results. However, with regard to the final test, while changes in total risk and idiosyncratic risk are negatively correlated with changes in GDP across the countries in the sample, changes in systematic risk are positively correlated with changes in GDP. The inconsistency in estimated correlation sign suggests that GDP growth does not provide a complete explanation for the decrease in risk that we observe across all three risk measures used in this study. We leave further analysis of this question to future research.

6. Conclusion

The aim of this paper is to assess the impact of EMU on euro-zone bank equity risk. We find that over 70% of the banks reduced their total risk. More than 60% of the banks exhibit a reduction in idiosyncratic risk and 64% of the banks exhibit a decrease in systematic risk. The banks that exhibit a decrease in bank equity risk are clustered in countries like Austria, France, Greece, Italy, Portugal and Spain. Our results are robust to a number of different test specifications.

Apparently, the euro-zone banking sector has been able to deal with the macroeconomic shocks arising from EMU. There has certainly been an increase in domestic and cross border merger activity since the formation of EMU and it has been argued that this has lead to an

[13] We thank the referee for alerting us to this possible problem.

increase in financial integration among the euro-zone countries. We also note a reduction in bank equity risk in some of the neighbouring non-euro-zone European country banks with the formation of EMU.

We argue that our analysis contributes to the literature dealing with the impact of regulatory change on the bank sector. The results portray an impressive picture of a banking system which has faced financial deregulation, comprehensive changes associated with EMU as well as several major financial crises. Yet, a large proportion of the commercial banks and bank holding companies across Europe exhibit reduced equity risk over the decade.

Our results are consistent with the contention that financial integration among the European banks may have resulted in reduced operating risk through decreased foreign exchange risk exposures, decreased differences in legislation and accounting and in simplification of European securities regulation. There has also been a rapid increase in bank merger and acquisition activity since 1999 with the beginning of EMU. These important changes could account for individual bank equity risk reduction that we note in this study. Furthermore, the reduction in risk in some non euro-zone European country banks suggests the possibility of spill over effects from the EMU. However, the reduction in risk in non euro-zone banking industry is not as pronounced as it is for EMU members.

While equity risk reduction is apparent in most countries in our sample, an important exception is the German banking industry, where we observe an increase in bank equity risk an average. The German banking industry is dominated by Sparkassen-Finanzgruppe which includes savings and Landesbanken. This peculiarity of the German banking system is said to have limited bank consolidation, lowered market concentration, and facilitated continuing

fragmentation in the market and may well explain the risk increases that we observe in this study.

Policy makers should perhaps focus on gaining a better understanding of what European bank capabilities helped them to reduce equity market risk while adapting to a rapidly changing economic climate. From the point of view of EMU, the major policy implication of this analysis is perhaps one of unintended consequences. While there was little academic discussion concerning the impact of EMU on the banks, it appears that EMU has had a marked impact on European bank equity risk. This decrease in risk occurs at the systematic, idiosyncratic and total risk level. And, while the majority of banks show a decrease in risk, there is a substantial number where a statistically significant decline in risk is observed. One question for future research is whether this decline in bank equity risk is due to bank portfolio diversification, bank mergers and acquisitions, increased equity holdings, changing income or the internationalization of the euro-zone banks as they take a more active part in the Eastern European markets.

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Table 1 Descriptive statistics of the sample

This table presents descriptive statistics for monthly returns for the euro-zone countries and the non-euro zone EU countries. All returns are in the local currency. Mean is the average return for the banks listed in the country, Median is the middle return observation for the banks, St. Dev. is the average monthly return standard deviation for the banks, Max. (Min.) is the maximum (minimum) return observed for any of the banks within the country, Skew is the average skewness value and Kurt. is the average kurtosis estimate for the banks in the country, Obs. refers to the number of bank-month observations available for the country and Banks refers to the number of bank shares included in the sample that are listed in the country. It should be noted that for the Finnish bank, Alandsbanken, both the A and the B shares are included in our sample. This leads to a total number of 96 banks from euro-zone countries and 85 banks from non euro-zone countries that are subject to analysis.

	Mean	*Median*	*St. Dev*	*Max.*	*Min.*	*Skew*	*Kurt.*	*Obs.*	*Banks*
Euro zone									
Austria	0.01	0.00	0.04	0.23	-0.21	0.70	6.57	613	5
Belgium	0.01	0.02	0.08	0.26	-0.39	-0.65	3.00	385	3
Finland	0.01	0.00	0.17	1.10	-1.14	-0.02	18.74	753	6
France	0.01	0.01	0.08	0.30	-0.52	-1.12	8.28	1035	7
Germany	0.01	0.00	0.10	0.83	-0.67	0.12	12.33	1468	11
Greece	0.02	0.01	0.14	1.01	-0.67	0.97	5.99	1360	9
Ireland	0.02	0.03	0.08	0.31	-0.28	-0.21	1.33	544	4
Italy	0.01	0.01	0.09	0.94	-0.56	0.89	8.86	3773	28
Netherlands	0.02	0.02	0.09	0.95	-0.41	1.48	19.45	544	3
Portugal	0.01	0.00	0.07	0.44	-0.28	0.66	5.05	774	6
Spain	0.02	0.01	0.07	0.41	-0.40	0.13	5.26	816	14
Non euro-zone									
Denmark	0.02	0.01	0.05	0.91	-0.41	2.78	34.78	6056	44
Norway	0.02	0.02	0.07	0.23	-0.40	-0.92	5.59	272	2
Sweden	0.01	0.01	0.09	0.46	-0.63	-0.75	6.65	638	5
Switzerland	0.01	0.00	0.07	0.55	-0.55	-0.21	13.08	3621	26
United Kingdom	0.01	0.01	0.09	0.44	-0.45	-0.49	3.05	986	8

Table 2 European bank sector risk versus European non-financial sector risk

This table reports the results of total, idiosyncratic and systematic risk estimation based on Datastream indices for the European region. We calculate changes in risk using the non-financial sector index and the banking sector index to provide an indication of the different effects observed with EMU for these two sectors. The total risk and idiosyncratic risk estimates are expressed as standard deviation. The systematic and idiosyncratic risk estimates are calculated using two MCSI indices, the MSCI Europe index and the MCSI World index. F-test Prob is the probability attached to the F-test for change in variance and t-stats refers to the t-test on the change in systematic risk across the period. To provide some indication of the change in risk exhibited across the euro-zone countries we repeat the analysis at the country level and count the number of countries reporting a decrease in risk (CN*) or an increase in risk (CN+) as well as the number of countries with a statistically significant decrease in risk (CN**) or a statistically significant increase in risk (CN++). These counts appear in the Difference columns of the table with the count of the statistically significant changes reported in parentheses.

	Total risk				*Idiosyncratic risk*				*Systematic risk*	
MSCI Indexes	Pre EMU	Post EMU	Difference	F test Prob	Pre EMU	Post EMU	Difference	F test Prob	Changes in β	t-stats
Europe Index										
Non Financial sector	0.037	0.048	0.011	0.054+	0.019	0.022	0.003	0.261	0.205	2.66*
CN* (CN**)			6 (3)				5 (2)		6 (3)	
CN+ (CN++)			5 (2)				6 (2)		5 (1)	
Banking sector	0.063	0.056	-0.007	0.372	0.031	0.030	-0.001	0.790	-0.198	-1.28
CN* (CN**)			7 (6)				7 (5)		9 (5)	
CN+ (CN++)			4 (1)				4 (1)		2 (0)	
World Index										
Non Financial sector	0.037	0.048	0.011	0.054+	0.024	0.026	0.002	0.645	0.287	2.68*
Banking sector	0.063	0.056	-0.007	0.372	0.044	0.035	-0.009	0.052+	-0.040	-0.210

*, + significant at 5% (10%) significance level

Table 3 Estimates of total risk and idiosyncratic risk of European banks

This table reports results of tests for change in bank equity total and idiosyncratic risk. The average of individual bank total risk estimates for pre EMU and post EMU periods for each country are reported in Panel A along with counts of the number of statistically significant individual bank total risk estimate changes. We use F tests for change in variance. Similar results are reported in Panel B for individual bank idiosyncratic risk estimates. N is the total number of banks that are included in risk calculations for the country. N* is the number of banks with a decrease in total risk. N** is the total number of banks with a statistically significant decrease in risk. N+ is the number of banks with an increase in total risk and N++ is the number of banks with a statistically significant increase in total risk at the 5% level of significance. Note that N could exceed the sum of N* and N+ where the risk estimates (to four decimal places) are unchanged. In this regard, N0 shows the number of banks that exhibit no change in risk estimates to four decimal places. Total risk is defined: $\sigma_{ri}^2 = 1/N \sum_{t=1}^{N} (R_t - \bar{R})^2$ where σ_{ri}^2 is the variance of the return for bank *i*, R_i return of bank *i* and $\bar{R}$ average bank *i* return. Idiosyncratic risk is defined as $\sigma_{\varepsilon}{}^2 = \sigma^2{}_{ri} - \beta^2 \sigma_{rm}^2$ where σ_{ri}^2 is the total risk for bank $_i$, σ_{ε}^2 bank return idiosyncratic risk and $\beta^2 \sigma_{rm}^2$ reflects the impact of systematic risk.

Panel A Estimates of total risk for individual banks using country index

Country	Average Pre EMU	Average Post EMU	Average Change	N	N0	N*	N**	N+	N++
Euro zone									
Austria	0.063	0.045	-0.018	5	1	4	3	0	0
Belgium	0.071	0.077	0.006	3	0	1	0	2	1
Finland	0.164	0.182	0.018	6	0	5	4	1	0
France	0.100	0.063	-0.037	7	1	5	5	1	1
Germany	0.210	0.114	-0.096	11	0	1	0	10	7
Greece	0.152	0.134	-0.018	9	0	7	4	2	1
Ireland	0.071	0.077	0.006	4	0	0	0	4	0
Italy	0.110	0.084	-0.026	28	0	22	17	6	1
Netherlands	0.089	0.084	-0.005	3	0	3	1	0	0
Portugal	0.095	0.063	-0.032	6	1	5	4	0	0
Spain	0.084	0.055	-0.029	14	0	14	11	0	0
Total euro zone	0.110	0.089	-0.021	96	3	67	49	26	11
Non euro zone									
Denmark	0.049	0.055	0.006	44	0	18	6	26	15
Norway	0.077	0.067	-0.010	2	0	2	0	0	0
Sweden	0.092	0.093	0.001	5	0	4	3	1	1
Switzerland	0.070	0.060	-0.010	26	1	16	11	9	4
United Kingdom	0.095	0.079	-0.016	8	0	6	3	2	1
Total non euro zone	0.077	0.071	-0.006	85	1	46	23	38	21

Panel B Estimates of idiosyncratic risk for individual banks using country index

Country	Average Pre EMU	Average Post EMU	Average Change	N	N0	N*	N**	N+	N++
Euro zone									
Austria	0.045	0.032	-0.013	5	0	5	2	0	0
Belgium	0.055	0.055	0.000	3	1	2	1	0	0
Finland	0.155	0.179	0.024	6	0	4	2	2	0
France	0.077	0.055	-0.022	7	0	5	5	2	1
Germany	0.055	0.100	0.045	11	0	2	1	9	7
Greece	0.114	0.032	-0.082	9	0	5	3	4	2
Ireland	0.055	0.063	0.008	4	0	0	0	4	0
Italy	0.084	0.071	-0.013	28	4	17	11	7	4
Netherlands	0.063	0.063	0.000	3	0	1	1	2	0
Portugal	0.071	0.055	-0.016	6	1	4	3	1	0
Spain	0.063	0.045	-0.018	14	0	13	11	1	1
Total euro-zone	0.076	0.068	-0.008	96	6	58	40	32	15
Non euro zone									
Denmark	0.047	0.051	0.004	44	0	15	5	29	17
Norway	0.059	0.055	-0.004	2	0	1	-	1	-
Sweden	0.071	0.066	-0.005	5	0	3	3	2	1
Switzerland	0.054	0.052	-0.002	26	0	13	9	13	6
United Kingdom	0.069	0.062	-0.007	8	0	5	3	3	1
Total non euro zone	0.060	0.057	-0.003	85	0	37	20	48	25

Table 4 Estimates of Systematic risk for European banks

Average individual bank systematic risk estimates (β) are reported by country for both the euro-zone and the non euro-zone countries. The β estimates are reported for total sample period and pre-EMU period along with the change in systematic risk that occurred with EMU in Panel A. These estimates are calculated using country equity market indices for both individual banks. N is the number of banking shares in the sample that are listed for the country. N* is the number of banks with a decrease in systematic risk and N** refers to the total number of banks with a statistically significant decrease in systematic risk at the 5% level of significance. N+ is the total number of banks that show an increase in systematic risk and N++ is the total number of banks that show a statistically significant increase in systematic risk at the 5% level of significance. The standard market model is used to measure systematic risk: $R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$ (see equation (1)) where, R_{it} is the return on security *i* at time period *t*, R_{mt} is the return on an equity market index at time period t. The systematic risk estimate for each bank or portfolio of banks is β_i (systematic risk) and ε_{it} is a random shock term. We extend the market model in equation (1) by introducing a dummy variable to capture the structural changes in systematic risk. The dummy variable (*D*) takes on a value of zero (0) for the months of January 1995 to December 1998 and a value of one (1) from January 1999 to April 2006. $R_t = \alpha_{pre} + (\alpha_{post} - \alpha_{pre})D + \beta_{pre}R_{mt} + (\beta_{post} - \beta_{pre})R_{mt}D + \varepsilon_t$ (See equation (2)).

Country	Average Full Period	Average Pre EMU	Average Change	N	N*	N**	N+	N++
Euro zone								
Austria	0.250	0.310	-0.120	5	4	2	1	0
Belgium	0.940	1.010	-0.110	3	1	1	2	0
Finland	0.170	0.490	-0.340	6	4	3	2	0
France	0.630	0.930	-0.480	7	5	4	2	0
Germany	0.560	0.560	0.010	11	7	3	4	1
Greece	1.110	0.990	0.220	9	3	1	6	1
Ireland	0.940	1.100	-0.230	4	4	0	0	0
Italy	0.820	0.800	0.040	28	15	5	13	4
Netherlands	0.990	0.860	0.030	3	3	0	0	0
Portugal	0.640	0.900	-0.450	6	6	3	0	0
Spain	0.510	0.620	-0.210	14	11	4	3	0
Total euro-zone	0.687	0.779	-0.149	96	63	26	33	6
Non euro zone								
Denmark	0.120	0.202	-0.123	44	33	9	11	0
Norway	0.622	0.702	-0.129	2	2	0	0	0
Sweden	0.734	0.916	-0.232	5	4	3	1	1
Switzerland	0.485	0.511	-0.04	26	14	4	12	1
United Kingdom	1.322	1.603	-0.375	8	5	4	3	0
Total non euro-zone	0.657	0.787	-0.180	85	58	20	27	2