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Do long-term bonds hedge equity risk? Evidence from Spain

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Abstract

We analyze the relationship between returns on equity and long-term government bonds in the Spanish economy. In particular, we are interested in the stability of the relationship across differing market conditions and if long-term bonds deliver diversification benefits during periods of equity market turbulence. Employing a Markov-switching vector autoregression model with three regimes, we find that the Spanish stock-bond relationship varies across market conditions and is positively correlated during 'Bear' markets. A sectoral analysis reveals that two sectors – Financials and Oil & Gas – are responsible for this positive comovement with the former being relatively more important.

Keywords: Stock-bond relationship; diversification; Spanish financial markets.

JEL Classification: G01

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1. Introduction

The stock-bond relationship is an important determinant of investors' portfolio choice. Long-term investors typically hold positive positions in both equity and government bonds despite stock returns out-performing bond returns over the long term. The main incentive for holding bonds appears to be for their potential diversification benefits. For example, Brennan and Xia (2000) and Campbell and Viceira (2001, 2002) all show that when allocating funds between U.S. equities and bonds, the demand for long-term bonds increases with both the investment horizon and the risk aversion of the investor.

The relationship between stock and bond returns has been extensively studied for the U.S. The early literature suggests that long-term bonds provide a good hedge or act as a 'safe haven' for equity investors. For example, Fleming et al. (1998) and Scruggs and Glabadanidis (2003) both find that stock market shocks elicit little response in measures of bond market risk. More recently, studies such as Baele et al. (2010) document substantial time-variation in the co-movements of stocks and bonds. One popular explanation is that the time-varying relationship depends on market conditions and that during episodes of stock market turbulence, there is a 'flight-to-safety' reaction whereby investors flee equity markets and take refuge in relatively safe assets, such as government bonds. Evidence consistent with this is provided by Connolly et al. (2005), Guidolin and Timmermann (2006), Anderson et al. (2008), Yang et al. (2009) and Flavin et al. (2014) among others, who all report a negative stock-bond relationship during equity market declines. This supports the view that government bonds provide an effective hedge against equity risk

This relationship also seems to hold during periods of financial market turbulence in non-U.S. markets. For example, Baur and Lucey (2009) find negative stock-bond correlations during equity market downturns for eight developed markets, while Chang and Hsueh (2013) confirm this finding for a group of Asia-Pacific countries. However, during the most recent financial crisis, a different pattern has begun to emerge for some of the Eurozone periphery countries. Jammazi et al. (2015) find a positive stock-bond relationship in Spain, Greece, Ireland, Portugal and Belgium since the beginning of the European sovereign debt crisis in late 2009. They attribute this to investors moving away from stock and government bond markets of peripheral countries to invest in economies with more solid fundamentals. Similarly, Acosta-González et al. (2016) report that, during the recent crisis, the correlation between bond and stock returns inverted from negative to positive in countries like Italy and Spain, while Flavin (2016), using a similar methodology to that employed here, finds positive co-movement between stock and bond returns in the crisis-hit peripheral Eurozone states during the most recent crisis. These studies imply that bonds may not always act as a safe haven for equity investors.

We re-visit this issue and focus on Spain. We choose Spain in an effort to explain the recent evidence of a positive stock-bond relationship during the crisis. While a single-country study may sacrifice geographical coverage, it allows us to delve deeper into the driving forces behind this change in stock-bond co-movement and apply a new methodology to a sectoral analysis of Spanish financial markets. Specifically we analyse the relationship for Spain using a Markov-switching vector autoregression (MS-VAR) model which allows us to assess the time-variation in the conditional correlation across market conditions. Furthermore, we generate regime-specific impulse response functions (IRFs) to study changes in the dynamics of the relationship across regimes. The analysis is conducted for the equity market index and at a finer level of disaggregation using ten sectoral indices. Our results confirm the aforementioned pattern at the market level, i.e. domestic long-term bonds and equity are positively correlated during stock market downturns. However, the sectoral analysis reveals that this result is mainly driven by two sectors – Financials and Oil & Gas – with returns on most other sectors displaying negative or zero co-movement with long-term bonds during bear markets. Given their relative size and the duration of their shocks, we argue that the Financial sector is relatively more important in explaining the stock-bond relationship at the overall market level.

The remainder of the paper is structured as follows. Section 2 describes the econometric methodology and our data. Section 3 presents our empirical results and discusses their implications, while section 4 contains our concluding remarks.

2. Econometric Methodology and Data

2.1 Econometric model: specification and estimation

We estimate bivariate MS-VAR models to study the time-varying relationship between Spanish equities and long-term government bonds. We specify the vector of dependent variables as $y_t = \{\text{equity return, bond return}\}_t$. The bond return is always the return on a 10-year sovereign bond but we employ different measures of the equity return in each model. Initially we focus on the total equity market index and then repeat the analysis at the sectoral level to provide a more disaggregated assessment of the relationship between Spanish equity and bond returns.

We study the stability of shock transmission across regimes by analyzing regime-dependent IRFs.[1] These allow us to study both the contemporaneous response of the asset returns to a stock market shock and the stability of the dynamics of shocks across regimes. As we primarily interested in the ability of government bonds to hedge

[1] Ehrmann et al. (2003) show how to generate regime-dependent IRFs in a Markov-switching VAR.

equity market risk, we order the variables so that the equity return affects both variables contemporaneously but bond market shocks only affect the stock market variable with a time lag. Given that stock market shocks are usually larger in magnitude and more frequent, we prefer to allow them have an immediate influence on both variables.

In our models, we allow for up to three distinct regimes, which we identify as 'Bull', 'Normal' and 'Bear' market conditions. As in Guidolin and Timmermann (2005), we find that two regimes are not sufficient to capture the market dynamics and hence opt for the higher dimension specification.

We estimate the following MS-VAR model:

$$y_t = \lambda(s_t) + \sum_1^p \theta_p(s_t) y_{t-p} + \varepsilon_t^{st} \tag{1}$$

$$S_t \in \{1,2,3\}$$

$$\varepsilon_t^{st} \sim i.i.d.(0, \sigma_s^2)$$

where y_t is a 2x1 vector as defined above. The regression constant (λ), the matrix of autoregressive coefficients (θ) and the covariance matrix of residuals (σ) are all regime-dependent. S_t is an unobservable latent variable, which takes a value of unity in 'Bull' markets, a value of 2 in 'Normal' market conditions and a value of 3 in 'Bear' markets. The evolution of the unobserved regime path is specified to be Markov switching and is endogenously determined by the data. The conditional matrix of transition probabilities has the following typical element:

$$\Pr[S_t = i \mid S_{t-1} = j] = p_{ij} \tag{2}$$

The model is estimated using a Bayesian Markov-chain Monte Carlo (MCMC) approach. We first specify the prior distributions for the parameters. For the variances, we employ a Wishart distribution, the VAR coefficients have a flat prior and we use a weak Dirichlet prior for the transitions, with a preference towards remaining in the same state. Using Gibbs sampling, we estimate the parameters and regimes in the following sequence;

Step 1: We draw the sigmas, given the mean coefficients and regimes.

Step 2: We draw the mean coefficients ($\boldsymbol{\lambda}$ and $\boldsymbol{\theta}$) given sigmas and regimes.

Step 3: We draw the regimes, given the sigmas and mean coefficients.

Step 4: We draw the transition parameters.

This sequence of steps is repeated 10,000 times after discarding an initial 'burn-in' set of 2000 replications. From the estimated parameters, we generate the regime-dependent IRFs and their associated confidence bands. The IRFs are the Choleski factors standardized to unit variances. This allows us to compare differences in dynamics rather than differences in variances, since what we are interested in is the stability of the shock transmission across regimes.

2.2 Data

Our data set consists of daily returns on Spanish equities and long-term government bonds. We employ Datastream-constructed total return indices for both the equity market (TOTMKES) and 10-year government bonds (BMES10Y). Later, we disaggregate the equity index into ten sectors. These are based on the FTSE's Industry Classification Benchmark and the sectors are Financials, Oil & Gas, Basic Materials, Industrials, Consumer Goods, Consumer Services, Telecoms, Technology, Utilities and Healthcare. Our sample covers the period from January 1st, 2004 to December 31st, 2015.

[Insert Table 1 about here]

Table 1 presents descriptive statistics for all return series. Panels A and B refer to the market-level and sectoral returns respectively. Panel A reveals that, over the sample period, the mean returns on equities and the 10-year bond are roughly the same, while the stock market index displays far greater volatility. In risk-return terms, bonds proved to be a much more attractive investment over the period. Both series are positively skewed and exhibit significant levels of kurtosis.

There are striking differences across the sectoral indices. Technology is the only sector to record a negative mean return but returns in the Financial, Oil & Gas, Telecoms and Basic Materials sectors are all below the overall market average. The poor performance of these sectors is further compounded by relatively high levels of risk, especially for Financial and Technology firms. In contrast, firms operating in the Consumer Goods, Consumer Services, Healthcare and Utilities sectors all outperform the market in terms of returns and have relatively low risk levels. The consumer goods sector is clearly the most stable sector in the Spanish equity market.

All sectoral returns exhibit skewness and strong evidence of kurtosis. With the exception of the Financial sector, all returns are negatively skewed. The prevalence of fat tails suggests that modeling these returns in a Markov-switching framework may be a better approach than in a single state setting.

3. Discussion of results

3.1 Results of the MS-VAR model

Bivariate MS-VAR models are estimated for the long-term sovereign bond return and the returns on each of the Spanish stock market indices described above. In all applications, we find that a three-regime specification is preferable to a more parsimonious representation. We identify the regimes from the estimated volatilities and they correspond to 'Bull', 'Normal' and 'Bear' phases of market dynamics. 'Bull' markets are characterized by positive growth and low volatility, 'Bear' regimes by negative returns and high volatility and 'Normal'[2] conditions combine zero returns with an intermediate level of volatility.

[Insert Tables 2 and 3 about here]

Tables 2 and 3 contain regime-specific estimates of expected returns and volatilities respectively, for both equities (all indices) and the 10-year government bond. The long-term bond generates positive expected returns (Table 2) across all three regimes, suggesting that volatility in the financial system is coming mainly from the equity markets. 'Bull' markets have positive expected returns for all equity indices; 'Normal' markets have approximately zero expected equity returns; while 'Bear' markets exhibit large negative stock returns. The largest declines are recorded in the Oil & Gas, Utilities and Industrial sectors. In general, the magnitude of returns in the 'Bear' regime is the largest but they are often imprecisely estimated due to increased volatility in the system. Focusing on results for the total equity-bond pairing reveals that both the expected bond return falls in the 'Bear' regime, indicating that both markets were suffering financial distress. Common factors such as liquidity shortages are likely to have played a role in both markets.

The asset volatilities (Table 3) confirm some stylized facts. Across all sectors, stock market returns are more volatile than returns in the bond market in all regimes. Furthermore, the volatility increases are far more pronounced for equity returns than bond returns as we move from 'Bull' to 'Normal' to 'Bear' regimes. The Telecoms and Technology sectors are the most volatile sectors during 'Bull' and 'Normal' regimes but these are surpassed by the Financial and Oil & Gas sectors during the 'Bear' regime.

[Insert Figure 1 here]

[2] Alternatively, this could be referred to as a 'stagnation' regime as the returns are very close to, and never statistically significantly different from, zero.

Figure 1 presents the smoothed probabilities of the regimes for the market-level analysis.[3] It shows the prevailing financial market conditions over the sample period. The initial period is a clear 'Bull' market regime, associated with strong stock market and economic growth. This is interspersed with short periods of 'Normal' market conditions before the first transition to a 'Bear' regime in late 2008 as the U.S. credit crisis transmitted to international markets following the collapse of Lehman Brothers.[4] 'Normal' conditions were re-established before the most prolonged 'Bear' period in 2011 when Spain looked likely to be drawn into the developing Eurozone sovereign debt crisis. 'Bear' regimes tend to be less persistent than other regimes but are associated with falling returns and increasing uncertainty. The sample ends in a mainly 'Normal' regime with some sporadic spurts of growth.

[Insert Table 4 about here]

Table 4 reports 'Duration' and 'Frequency' statistics for the three regimes across all models. 'Duration' (measured in days) captures the average time for which each state persists, while 'Frequency' measures the proportion of time that the system spends in each of the regimes. Consistent with Figure 1, we find that 'Bear' markets have relatively short duration – about 7 days in the case of the market index – and most often account for the shortest proportion of time. On average, across sectors, a high-volatility shock persists for nearly 10 days but ranges from 4 days in the case of Consumer Goods to 17 days in the model for Consumer Services. The latter also experiences the most protracted 'Bear' regime and spends about 41% of the sample period in this tumultuous state. At the other extreme, Oil & Gas spends just 9% of the time in the highest-volatility state and shocks die out after about 5 days. We already

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[3] Similar graphs are available for each application of the model and are available upon request. However to conserve space, we do not include the graphs for the sectors.

[4] Aït-Sahalia et al. (2009) attribute (in part) the 'internationalization' of the U.S. crisis to liquidity shortages following the fall of Lehman Brothers in September 2010.

noted that this sector exhibited very high volatility during the bear regime so these regimes are short, rare but intense.

Given the prolonged period of economic growth that preceded the bust, 'Bull' markets prevail for a great deal of time, especially for the Telecom, Utilities and Consumer Goods sectors. Positive shocks are persistent, with a duration of about 19 and 37 days for the total market and the financial sector, respectively. 'Normal' regime shocks persist for between 12-19 days across sectors and their frequency varies greatly across sectors.

[Insert Table 5 about here]

Table 5 presents estimates of the transition probabilities for the total market and each sector, with p_{ij} denoting the probability of moving from regime j to i. All regimes are quite persistent, especially 'Bull' and 'Normal' states. For example, in the total market-bond application, the probability of remaining in the 'Bull' or 'Normal' regime, given that is where you were one period ago, is 0.946 and 0.927 respectively. 'Bear' regimes are slightly less persistent, with a corresponding probability of staying in this state of 0.861.

Continuing to focus on the total market specification, we find that having started in 'Bull' regime, the financial system is more likely to transit to a 'Normal' rather than a 'Bear' regime (i.e. $p_{21} > p_{31}$). Upon leaving the 'Normal' regime, the probabilities of moving to a 'Bull' or 'Bear' regime are roughly equal, while a movement out of a 'Bear' regime has a higher probability of being to a 'Normal' rather than a 'Bull' regime. This pattern is replicated for the sectoral analysis of Financials and Oil & Gas. The other sectors are more likely to make larger jumps between regimes with movements between extreme regimes relatively more common, with movements out of 'Bull' and 'Bear' regimes often tending to bypass the 'Normal' regime. For example, both the Telecom and Technology sectors have much greater probability of moving from a ‘Bear’ to a ‘Bull’ rather a ‘Normal’ regime, (i.e. $p_{13} > p_{23}$).

3.2 Regime-specific correlations.

Table 6 presents the regime-specific correlations generated by the MS-VAR model. Though not a statistical test for the stability of relationships, they provide an overview of the changes in comovement between the three regimes.

[Insert Table 6 about here]

A number of interesting features of the relationship emerge from this analysis. Firstly, ‘Bull’ markets are predominantly associated with negative comovement between the two asset classes. The only exception is the Telecom sector which displays small but positive correlation with the long-term government bond. For all other sectors, equity and bond returns tend to move in opposite directions during periods of positive stock market news as investors re-balance portfolios in favor of the high-yielding asset. Secondly, during ‘Normal’ market conditions, the correlations all turn positive, implying that returns to both assets move in the same direction in response to shocks during this relatively stagnant period. Thirdly, the sign of the correlation is not uniform across stock market sectors during ‘Bear’ regimes. Returns to the total Spanish stock market index and the long-term bond are positively correlated. As ‘Bear’ regimes are characterised by negative shocks, this suggests that Spanish bonds do not act as ‘safe-havens’ for investors in the Spanish equity market. However, our sectoral analysis reveals some heterogeneity in the comovements, with only Financials and Oil & Gas exhibiting this tendency for positive comovement during ‘Bear’ markets. For the other eight sectors, there is a negative stock-bond correlation.

3.3 Impulse Response Functions – transmission of cross-market shocks

Thus far, the analysis suggests that bonds have some diversification benefits for equity investors but their effectiveness varies across sectors of the equity market. We require a more thorough statistical investigation of the stock-bond relationship across different market conditions. Regime-dependent IRFs, as proposed by Ehrmann et al. (2003), are ideally suited to show the changes (and their statistical significance) in the transmission of structural shocks across different market conditions. We present these here to analyze the transmission of shocks and their cross-market effects. The IRFs allow us to analyze the sign of the responses in each regime and changes in the dynamics of the relationship across regimes.

3.3.1 Market-level analysis

Firstly, we focus on the total equity market and the long-term sovereign bond relationship. Figure 2 presents the IRFs, with 95% confidence bands. The top row of each figure shows the bond market reaction to a stock market shock, while the bottom row illustrates the stock market reaction to a bond market shock. The columns represent the market regime

[Insert Figure 2 about here]

The bond market reacts negatively (opposite in sign) to the equity market shock during 'Bull' market conditions. This is consistent with investors liquidating bond portfolios to increase their exposure to the equity market in pursuit of increased returns. While the contemporaneous shock exerts a negative and statistically significant effect on the bond market, the shock quickly dies out and the dynamics are not statistically different from zero.

Bond markets, during the 'Normal' regime, respond differently. Now the contemporaneous reaction is positive (of the same sign) and stays in the system for about one day. During such market conditions, investors don't seem to alter the composition of their portfolios.

'Bear' market episodes are still associated with a positive contemporaneous shock. This is consistent with the earlier results on the regime-dependent correlations and confirms the aforementioned results of Jammazi et al. (2015), Acosta-González et al. (2016) and Flavin (2016) for the Spanish market. The reaction to the shock is more persistent than in the other regimes and although it turns negative (while remaining statistically different from zero) on days 2-4 after the shock, the sum of the reactions is positive, suggesting that overall the diversification benefits of sovereign bonds are limited following an equity market shock.

Focusing on the lower row, we find that across all regimes, a bond market shock elicits little reaction from the stock market. In general, the responses are not statistically significant and there is little evidence of feedback effects from the sovereign bond to the stock market. Hence, we infer that bond market shocks have little impact on equity investors.

3.3.2 Sectoral-level analysis

The market-level result is at odds with the extant literature, which generally finds that long-term sovereign bonds act as a 'safe-haven' asset for equity investors during stock market crises. To shed more light on the stock-bond relationship for the Spanish financial system, we conduct our analysis at a finer level of disaggregation using ten stock market sectoral indices. Figure 3 shows the IRFs.

[Insert Figure 3 about here]

The sectoral analysis produces a number of noteworthy results. Firstly, there is a great deal of uniformity in the bond market response to an equity shock across all sectors during both ‘Bull’ and ‘Normal’ regimes. During the low-volatility ‘Bull’ state, there is a negative contemporaneous response in the sovereign bond market following a shock to any one of nine sectors, consistent with our total market response above. The only exception is recorded for an Industrial sector shock which elicits a positive, but not statistically distinguishable from zero, response in the government debt market. The magnitude of the response is relatively small in this regime and shocks die out quickly. In most cases, their influence is limited to the initial day.

A similarly consistent pattern emerges during the ‘Normal’ regime, even though the bond market response is of the opposite sign. A shock to any equity market sector generates a positive response in the bond market and its magnitude ranges from 0.025 to 0.28. Shocks are a little more persistent relative to the ‘Bull’ market but generally their influence has dissipated within 3-4 days.

Secondly, the high-volatility ‘Bear’ regime is where the sectoral analysis provides most insight into the total market behavior. The earlier finding that Spanish equity and sovereign bond returns were positively correlated during market downturns appears to be driven by just two sectors; namely Financials and Oil & Gas. Furthermore, shocks to both of these sectors exhibit more persistence during the ‘Bear’ market than in other market conditions. Given their relative size[5] (see Figure 4), it seems that Financials are the main cause of this positive comovement during the crisis episode. This is consistent with the argument that, generally, financial crashes lead to debt crises (Reinhart and Rogoff, 2011) and that, specifically, during the most recent crisis,

[5] Over our sample period, Financials dominate the Spanish market. On average, they account for 34% of total market capitalization over this period. Oil & Gas accounts for about 6.3% on average. Thus the Financial sector is about 5 times larger than the Oil & Gas sector.

difficulties in the domestic banking sector caused price declines and increased uncertainty for domestic sovereign bonds (see Acharya et al., 2014; and Mody and Sandri, 2012). Our evidence shows that shocks to the domestic financial sector exerted an adverse influence on the market for Spanish government debt. The bailout of the Bankia group in December 2010 and its subsequent partial nationalization in May 2012 saw a transfer of banking debts and risks to the sovereign, thus inextricably linking the banking sector and government debt. The increased fiscal burden on the Spanish government led to an increased risk premium on sovereign debt. The simultaneous declines were likely further exacerbated by the banks' relatively large holdings of domestic debt, thereby reinforcing the 'doom loop' of banks and sovereign debt.

A shock to the Oil & Gas sector generates a similar response in the bond market, but it is worth recalling that the 'Bear' regime for this sector has the shortest duration and lowest frequency so that coupled with its size, it is likely to wield less influence on the overall market behavior relative to the Financial sector. The positive comovement between the returns of the Oil & Gas sector and sovereign bonds may be attributed to two features of this market. Firstly, Spanish energy markets are heavily regulated, with the state assuming responsibility for mechanisms to cover any income shortfalls of energy providers. The so-called 'déficit de tarifa' means that adverse shocks for this sector also impact on the sovereign who have to meet greater funding requirements. The coincidence of this 'Bear' regime with an already sensitive period in Eurozone sovereign debt markets contributes to the positive comovement. Secondly, the Spanish Oil & Gas sector is almost totally dependent on imports. The International Energy Agency (2014) reports that both Oil and Gas imports constitute approximately 99% of domestic consumption. With imports being predominantly sourced outside the Euro zone, this sector is highly vulnerable to exchange rate risk. The Euro zone sovereign debt crisis weakened the euro on foreign exchange markets meaning that there was a strong link between the falling bond prices and the stock prices on the import-reliant Oil and Gas sector.

[Insert Figure 4 about here]

Shocks to the other eight stock market sectors generate a more homogeneous response in the bond market. The contemporaneous reaction is small but negative and exhibits little persistence. Bond markets are not very sensitive to events in these sectors during stock market downturns. This is consistent with the empirical evidence from non-crisis countries. Thus, sovereign bonds still offer diversification benefits for equity investments in these eight sectors but such benefits are limited for holders of stocks in the Financial and Oil & Gas sectors.

An examination of the feedback effects from a bond market shock to the stock market sectors reveals that there are little or no such effects in ‘Bull’ or ‘Normal’ markets. During ‘Bear’ regimes, there is some limited evidence of statistically significant feedback effects to the Financials, Basic Materials, Healthcare, Telecoms and Utilities sectors on the day after a bond market shock. These effects are short lived with none persisting for more than a single day.

In summary, the sectoral analysis shows that the bond market response to an equity market shock is homogeneous during more benign market conditions but becomes more heterogeneous during stock market downturns. The positive correlation between returns on the total stock market and long-term sovereign bonds during ‘Bear’ markets appears to be mainly driven by the Financials sector, and the Oil & Gas sector to a lesser extent. It is consistent with the transfer of previously private banking debts to the sovereign during the bailout and recapitalization programs extended to impaired domestic banks by the government. Sovereign bonds do not provide a good hedge for the risks of these sectors as their risks tend to transfer to government during crisis periods.

4. Conclusions

We examine the stock-bond relationship for Spain and consider the ability of long-term government bonds to hedge against equity market risk. The recent literature suggests that Spain is different to other big developed financial markets in that returns to equity and sovereign bonds are positively correlated during a stock market crisis and hence bonds offer limited diversification benefits to equity investors. Employing a MS-VAR model, we confirm this result for the total market. However, a sectoral analysis sheds greater light on the driving force behind this finding. In fact, just two sectors – Financials and Oil & Gas – appear to generate this positive comovement at the market level. Given the relative size of the sectors and the relative frequency and duration of their adverse shocks, we posit that the Financial sector is predominantly responsible for this positive correlation. Two-way feedbacks between domestic banks and sovereign debt markets served to amplify the initial financial disturbance through the transfer of banking debts and risks to the sovereign during the crisis and relatively large holdings of domestic government by the banking sector. This meant that the fortunes of the banking sector and sovereign debt instruments became inextricably linked and that sovereign bonds were no longer suitable 'safe-haven' assets for holders of financial stocks.

Shocks to the other stock market sectors do not impact greatly on sovereign bonds during episodes of high market volatility. Bond reactions tend to be small, negative and display little persistence, thus making bonds a suitable hedge for investors in these equity market sectors.

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Table 1: Summary Statistics

	Mean	**Volatility**	**Skewness**	**Kurtosis**
Panel A				
Equity Market	0.0255	1.3332	0.0345	5.9083
10-year Bond	0.0259	0.4833	0.9671	15.3000
Panel B				
Financials	0.0094	1.7869	0.3592	8.7324
Basic Materials	0.0193	1.4335	-0.1820	3.4578
Industrials	0.0315	1.3331	-0.3150	3.6935
Consumer Goods	0.0404	0.8848	-0.0641	8.5577
Consumer Services	0.0565	1.4619	0.1580	4.0571
Telecoms	0.0201	1.4562	-0.0545	5.6547
Technology	-0.0123	1.6872	-1.4511	28.3445
Utilities	0.0420	1.3401	-0.0761	7.3695
Healthcare	0.0518	1.3511	-0.6001	7.6829
Oil & Gas	0.0097	1.5794	-0.3471	6.1392

Notes: This table presents summary statistics for the daily percentage returns on the total stock market index, the 10-year government bond, and the sectoral equity indices used in the study.

Table 2: Estimates of Expected Returns across Regimes

10-year bond with	Expected Return					
	Bull Market		Normal Market		Bear Market	
	μ_E	μ_B	μ_E	μ_B	μ_E	μ_B
Total Equity Market	0.161 (0.026)	0.016 (0.009)	-0.034 (0.038)	0.028 (0.012)	-0.213 (0.141)	0.013 (0.050)
Financials	0.126 (0.025)	0.014 (0.008)	-0.013 (0.043)	0.036 (0.011)	-0.132 (0.154)	0.013 (0.041)
Basic Materials	0.153 (0.032)	0.023 (0.008)	-0.081 (0.065)	0.005 (0.037)	-0.217 (0.084)	0.031 (0.017)
Industrials	0.160 (0.024)	0.029 (0.008)	-0.044 (0.060)	0.013 (0.032)	-0.236 (0.090)	0.031 (0.017)
Consumer Goods	0.071 (0.016)	0.024 (0.008)	-0.019 (0.036)	0.007 (0.031)	0.021 (0.078)	0.043 (0.023)
Consumer Services	0.153 (0.024)	0.021 (0.008)	0.061 (0.077)	0.018 (0.037)	-0.030 (0.057)	0.032 (0.012)
Telecoms	0.081 (0.024)	0.024 (0.007)	-0.128 (0.093)	-0.009 (0.041)	-0.158 0.125	0.042 (0.029)
Technology	0.080 (0.026)	0.016 (0.007)	-0.104 (0.085)	0.006 (0.037)	-0.195 (0.114)	0.064 (0.021)
Utilities	0.112 (0.019)	0.027 (0.007)	-0.013 (0.070)	0.011 (0.034)	-0.273 (0.135)	0.032 (0.026)
Healthcare	0.118 (0.025)	0.027 (0.008)	0.116 (0.054)	0.024 (0.031)	-0.134 (0.073)	0.026 (0.015)
Oil & Gas	0.103 (0.027)	0.023 (0.007)	-0.022 (0.055)	0.020 (0.016)	-0.355 (0.245)	0.019 (0.077)

Notes: This Table presents the expected returns, generated by the estimated model, for equities (μ_E) and the 10-year government bond (μ_B) in each of the regimes. The numbers in parentheses are standard errors.

Table 3: Estimates of Volatilities across Regimes

	Volatilities					
	Bull Market		Normal Market		Bear Market	
10-year bond with	σ_E^2	σ_B^2	σ_E^2	σ_B^2	σ_E^2	σ_B^2
Total Equity Market	0.370	0.055	1.571	0.160	6.274	0.879
	(0.027)	(0.003)	(0.097)	(0.009)	(0.566)	(0.083)
Financials	0.512	0.059	2.346	0.141	10.936	0.773
	(0.029)	(0.003)	(0.116)	(0.008)	(0.910)	(0.063)
Basic Materials	0.771	0.069	1.861	0.694	4.717	0.184
	(0.046)	(0.003)	(0.143)	(0.054)	(0.323)	(0.012)
Industrials	0.642	0.072	1.982	0.654	4.284	0.143
	(0.033)	(0.004)	(0.133)	(0.046)	(0.299)	(0.009)
Consumer Goods	0.336	0.076	0.711	0.644	2.508	0.156
	(0.021)	(0.004)	(0.050)	(0.051)	(0.279)	(0.019)
Consumer Services	0.464	0.060	2.714	0.708	3.537	0.145
	(0.032)	(0.003)	(0.201)	(0.066)	(0.199)	(0.036)
Telecoms	0.908	0.077	3.492	0.737	5.155	0.238
	(0.049)	(0.004)	(0.285)	(0.073)	(0.619)	(0.056)
Technology	0.901	0.072	3.692	0.732	7.284	0.185
	(0.052)	(0.004)	(0.264)	(0.067)	(0.746)	(0.016)
Utilities	0.627	0.078	2.648	0.698	6.079	0.195
	(0.027)	(0.003)	(0.191)	(0.054)	(0.653)	(0.017)
Healthcare	0.600	0.067	1.683	0.646	3.875	0.141
	(0.040)	(0.004)	(0.116)	(0.046)	(0.260)	(0.009)
Oil & Gas	0.825	0.067	2.793	0.209	10.388	1.095
	(0.059)	(0.003)	(0.255)	(0.023)	(1.627)	(0.170)

Notes: This Table presents the regime-specific variances, generated by the estimated model, for equities (σ^2_E) and the 10-year government bond (σ^2_B). The numbers in parentheses are standard errors.

Table 4. Characteristics of regimes

	Duration			Frequency		
	Bull	**Normal**	**Bear**	**Bull**	**Normal**	**Bear**
Equity Market	18.6	13.7	7.3	36.9	49.7	13.4
Financials	37.5	18.9	8.7	32.7	50.6	16.7
Basic Materials	23.3	15.6	13.5	54.8	18.5	26.7
Industrials	20.7	13.6	15.0	55.4	22.3	22.3
Consumer Goods	13.5	15.5	4.2	60.3	22.6	17.1
Consumer Services	18.3	15.7	17.6	40.3	18.6	41.1
Telecoms	18.9	18.2	5.6	65.6	17.2	17.2
Technology	13.6	16.9	5.6	58.5	19.3	22.2
Utilities	29.5	11.5	12.0	65.9	20.5	13.6
Healthcare	16.0	16.8	11.0	48.2	22.6	29.2
Oil & Gas	31.2	11.9	4.7	51.2	39.8	9.0

Notes: This Table presents ‘Duration’ and ‘Frequency’ statistics for each of the regimes in each of the estimated models. Each model is estimated with the returns on the 10-year government bond and an equity market index. Duration is the average length of time (measured in days) for which a given regime persists, while ‘Frequency' is the proportion of time that the returns spend in each regime in the ‘steady state’.

Table 5. Transition Probabilities

	p_{11}	p_{21}	p_{31}	p_{12}	p_{22}	p_{32}	p_{13}	p_{23}	p_{33}
Total Market	0.946	0.051	0.003	0.038	0.927	0.035	0.006	0.133	0.861
Financials	0.973	0.025	0.002	0.016	0.974	0.036	0.003	0.111	0.886
Basic Mats.	0.958	0.016	0.026	0.035	0.936	0.029	0.063	0.011	0.927
Industrials	0.952	0.026	0.022	0.062	0.927	0.011	0.058	0.009	0.934
Cons. Goods	0.927	0.017	0.056	0.037	0.935	0.028	0.210	0.025	0.765
Cons. Services	0.946	0.014	0.040	0.025	0.936	0.039	0.042	0.015	0.943
Telecoms	0.948	0.012	0.040	0.036	0.945	0.019	0.168	0.011	0.820
Technology	0.927	0.016	0.057	0.027	0.941	0.032	0.169	0.009	0.822
Utilities	0.966	0.023	0.011	0.067	0.913	0.020	0.063	0.021	0.916
Healthcare	0.937	0.020	0.043	0.035	0.940	0.025	0.076	0.014	0.910
Oil & Gas	0.968	0.030	0.002	0.039	0.916	0.045	0.009	0.205	0.786

Notes: This Table presents the transition probabilities for moving between the regimes in each application. Each row represents the 3x3 matrix of transition probabilities from the model of the 10-year government bond and the stated equity index. p_{ij} denotes the probability of moving from regime j to i. Regime 1 is the 'Bull' regime, 2 is the 'Normal' regime and 3 is the 'Bear' regime.

Table 6. Regime-Specific Correlations

	Bull	Normal	Bear
Total Market	-0.0964	0.0907	0.2336
Financials	-0.1018	0.1302	0.2388
Basic Materials	-0.0902	0.4186	-0.1295
Industrials	-0.0156	0.4195	-0.2548
Cons. Goods	-0.0516	0.2695	-0.0790
Cons. Services	-0.0444	0.3294	-0.0903
Telecoms	0.0136	0.4706	-0.2031
Technology	-0.1376	0.3640	-0.0578
Utilities	-0.0396	0.4773	-0.2117
Healthcare	-0.0508	0.2776	-0.1800
Oil & Gas	-0.1583	0.0622	0.2983

Notes: This presents the regime-dependent pairwise correlations between long-term bonds and equities market generated by our *MS-VAR* model.

Figure 1. Regime Probabilities

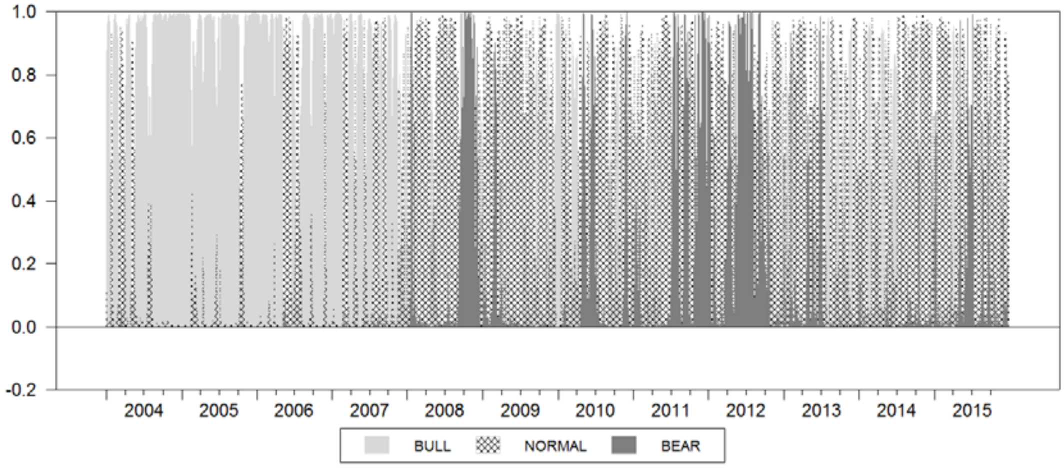


Figure 2. Cross-Market Response to a Shock – Total Market Analysis

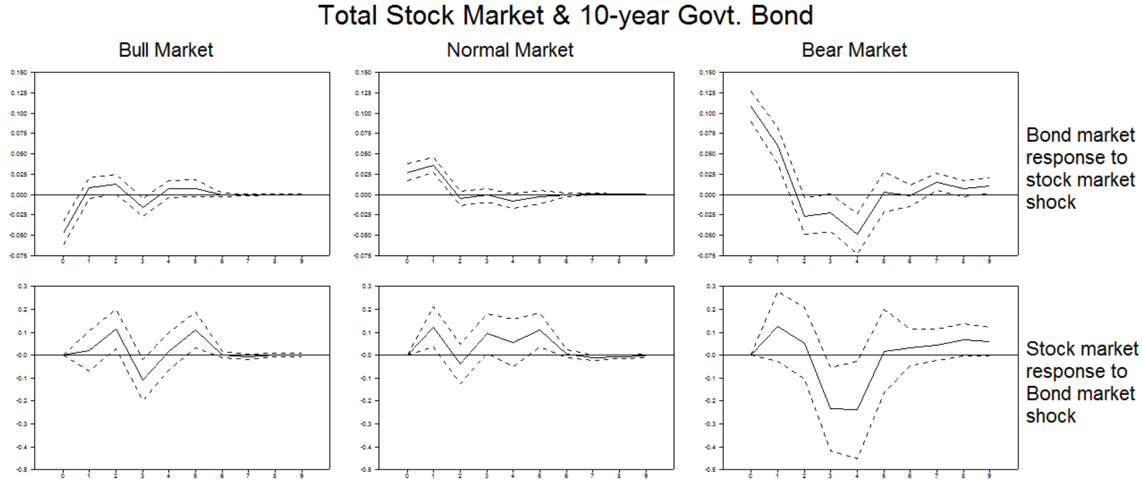
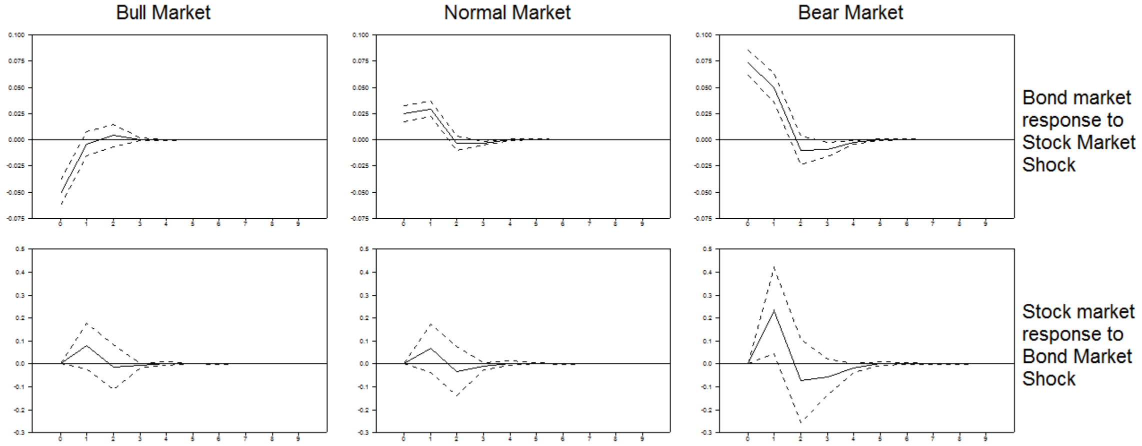
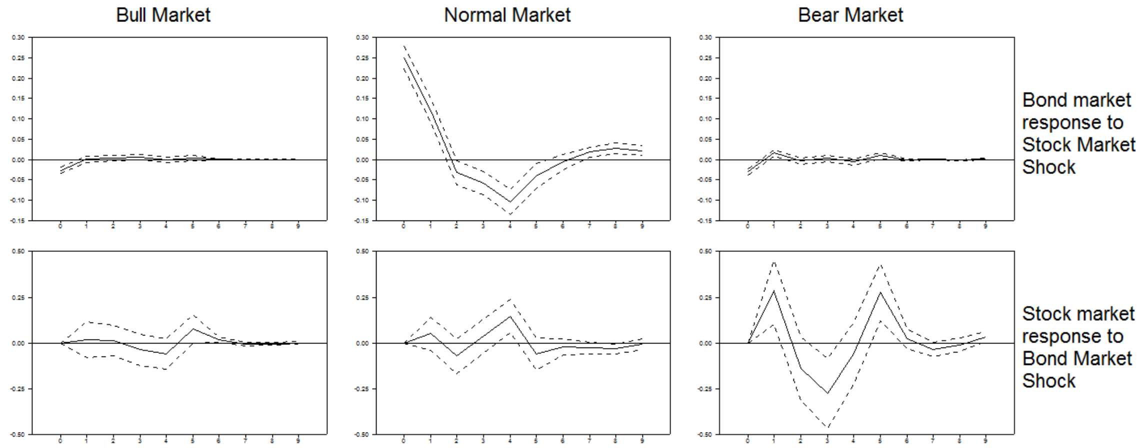


Figure 3. Cross-Market Response to a Shock – Sectoral Analysis

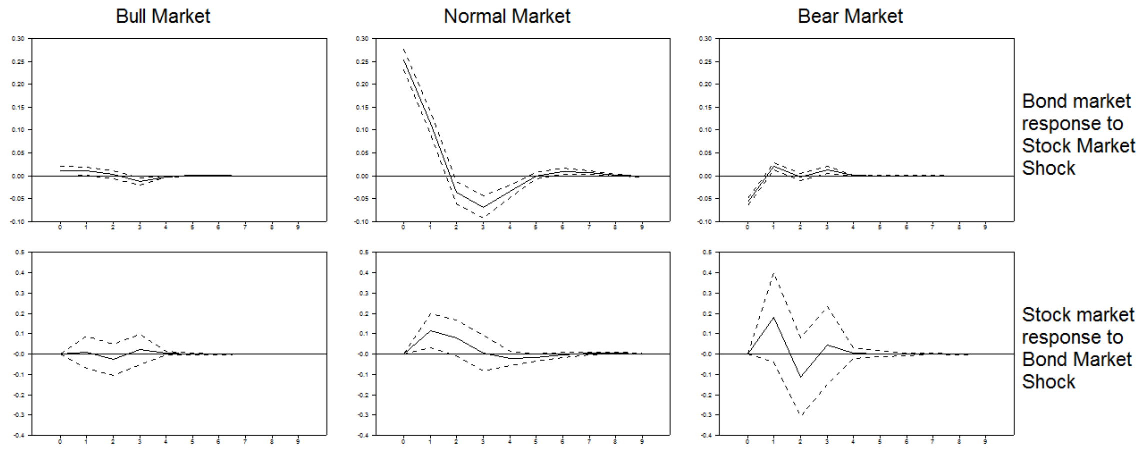
Financials & 10-year Govt Bond



Basic Materials & 10-year Govt Bond



Industrials & 10-year Govt. Bond



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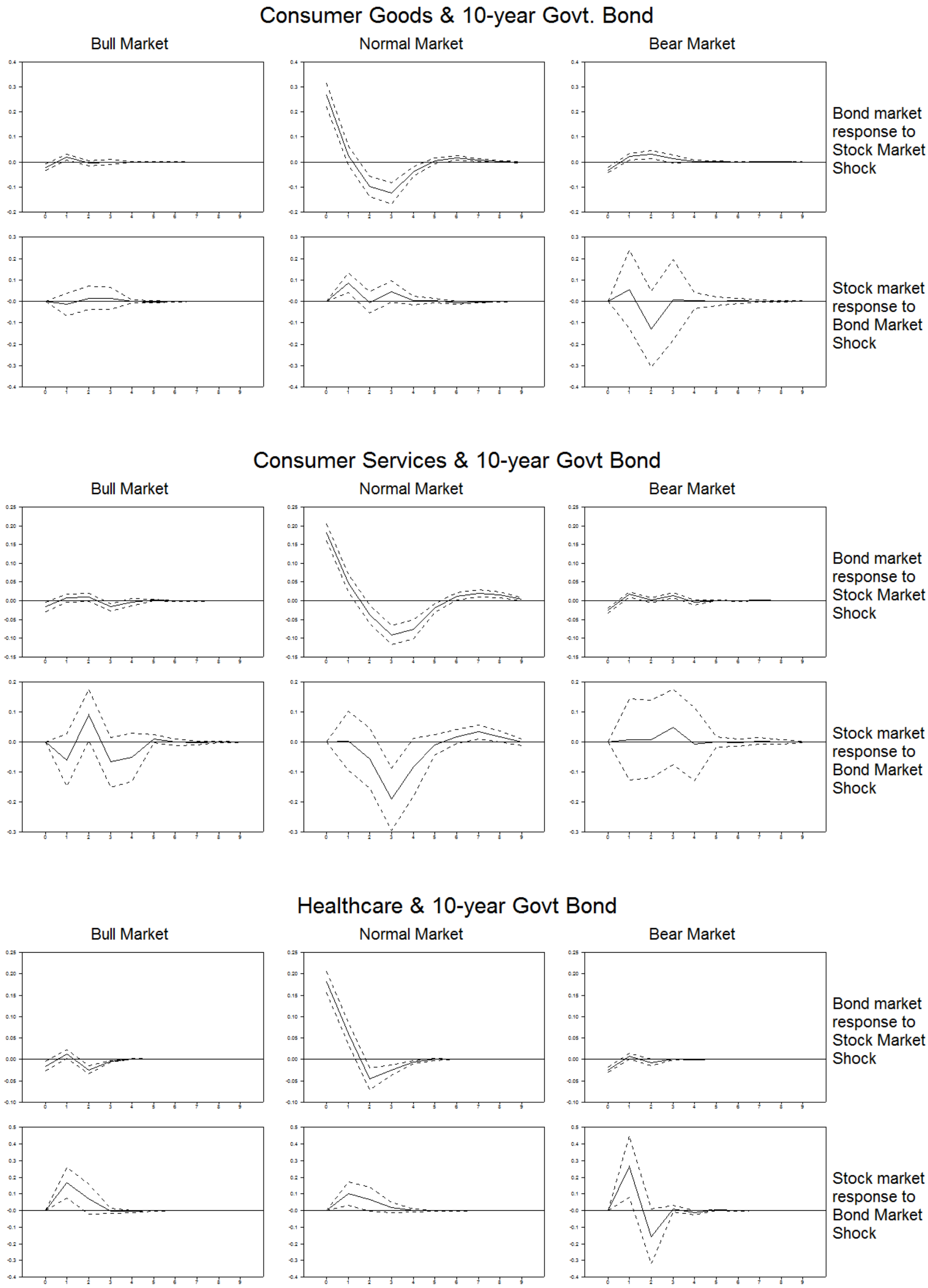

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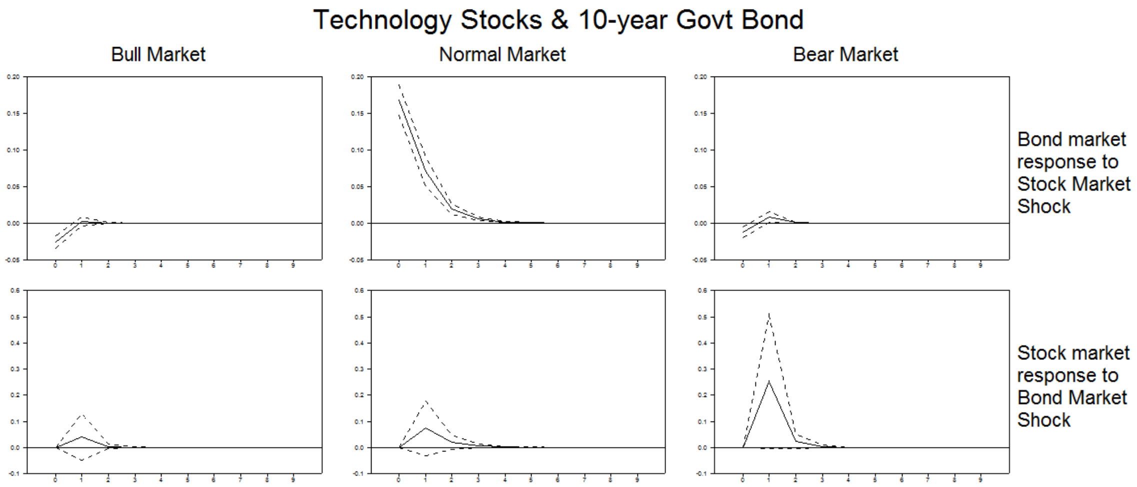

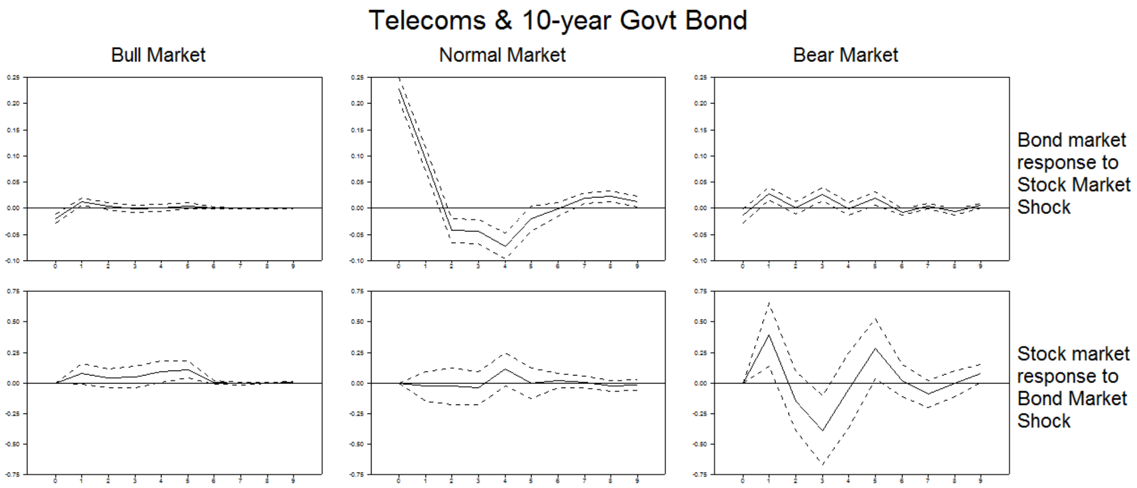

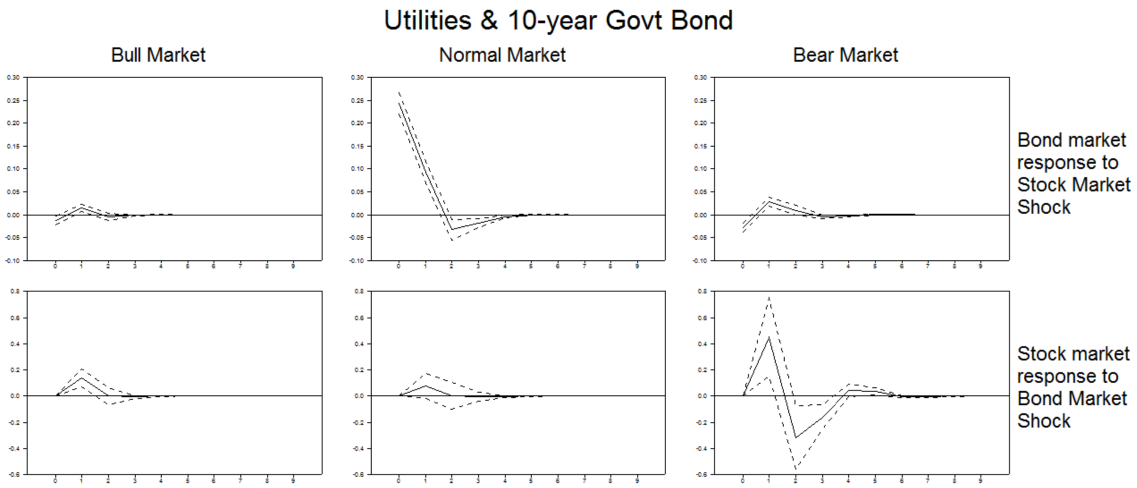

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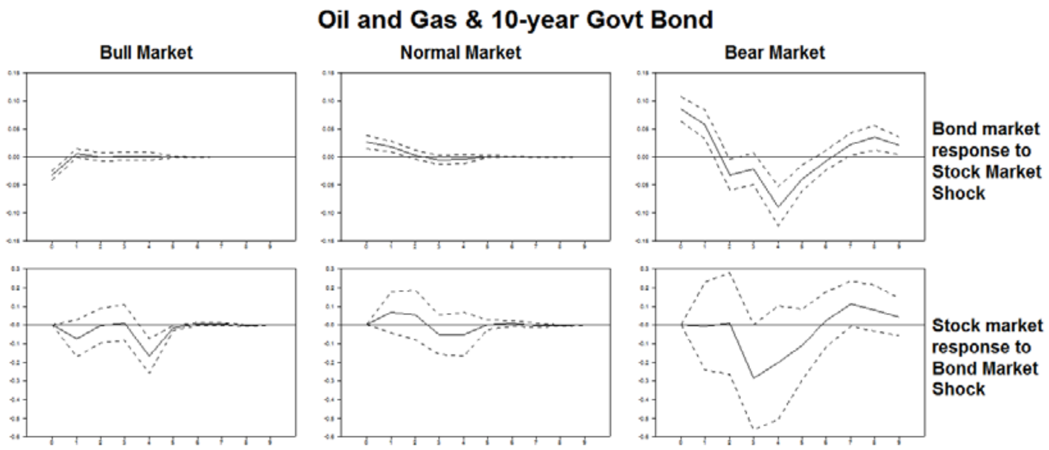
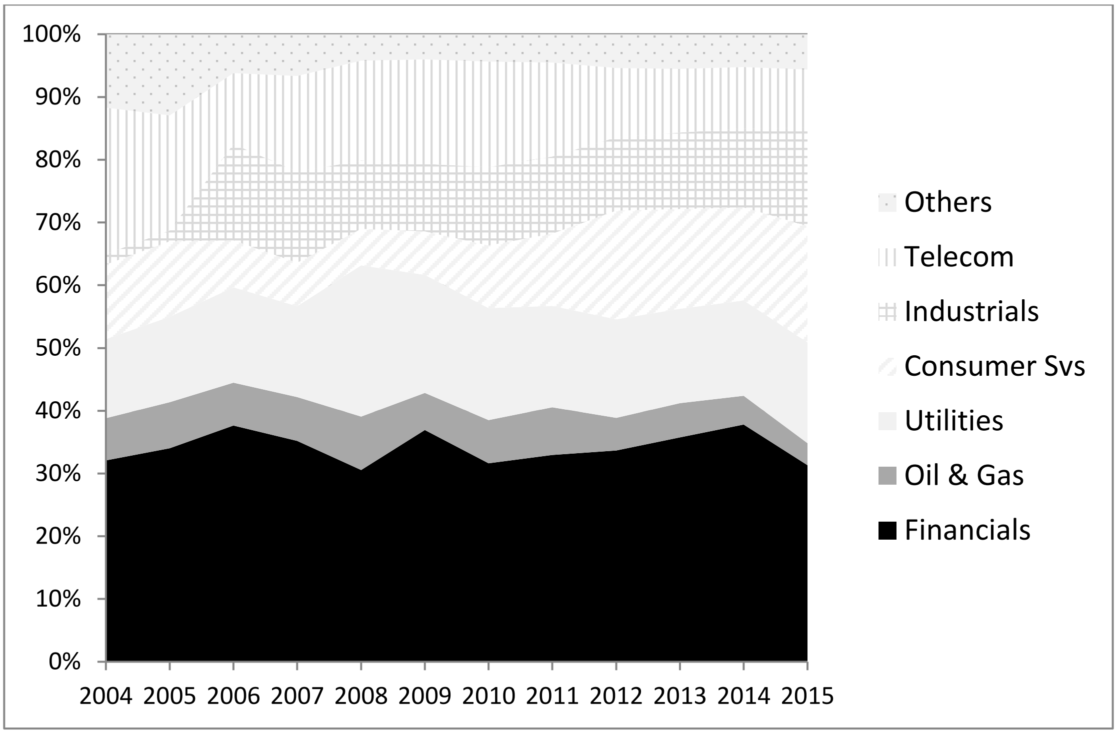


Figure 4. Relative Size of Spanish Stock Market Sectors



Notes: This Figure shows the proportion of the total stock market value that was attributed to each of the indicated sectors at the end of each year of our sample. Financials dominate the market, accounting for 34% of total market capitalization on average and ranging from 31% to 38% over our sample. Others include Basic Materials, Consumer Goods, Healthcare, and Technology.