Sovereign Commitment in ECB Announcements: Identifying a New Channel in Euro Area Monetary Policy and How It Interacts with Sovereign Bias*

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Abstract

In the first stage of this paper I argue for the existence of an additional channel through which monetary policy announcements of the ECB affect bond yields in the euro area. I label this factor sovereign commitment, as it explains the differential reaction of bonds of crisis stricken country vis-a-vis zero-risk sovereign bond yields. I identify this factor using principal component analysis of bonds of different maturities and risk profiles. In the second stage I proceed to project the effect of this new sovereign commitment channel on bond yields on the balance sheets of representative banks in Germany, France, Spain and Italy. I argue that due to the increased sovereign exposure banks develop during crises the sovereign commitment channel strengthens crisis-stricken countries' banks disproportionately.

Word Count : 8500

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Introduction

Today the European Central Bank (ECB), as the central bank of the Euro Area, directs the monetary policy of 19 countries in the European Union (EU). Since its inception in 1998 there has been a debate about the implications of delegating monetary policy to a supranational institution while keeping fiscal policy as a national competence. One main point of criticism has been that the ECB cannot adequately support the economy when countries simultaneously find themselves at different stages of the business cycle. This paper aims to present an argument as to why the ECB's monetary policy may still support crisis-stricken countries disproportionately, through the effect of a channel I label sovereign commitment on banks' balance sheets.

The expression "sovereign commitment" channel is chosen to capture moves by the ECB which implicitly lower the probability of default of countries in the Euro Area as perceived by financial markets and is empirically distinguishable from the three main channels target rate, forward guidance and quantitative easing, which are widely discussed in the literature and constitute the toolkit of central banks to affect the short and long curve of the yield curve. The existence of a sovereign commitment channel in this form is likely to be unique to the ECB, due to it governing monetary policy for – abstracting from the EU budget rules – fiscally independent countries. Other central banks, for instance the Federal Reserves Bank or the Bank of England, do not share this characteristic.

Even though the term monetary policy surprise is fairly well established in the literature, I believe it is crucial to set out why the approach is an important alternative to a simple binary measure of policy announcements. At the heart of the concept of monetary policy surprises lies the efficient market hypothesis. Modern monetary policy essentially amounts to controlling the term structure of sovereign debt by setting interest rates on reserves as well as its expectations. These expectations are mainly shifted by the ECB's own announcements, however, only if the announcements constitute novel information, i.e. surprises. In other words, if markets expect a certain move in the ECB's policy, yield curves will adjust immediately. Otherwise, this would constitute an arbitrage opportunity. In an extreme case, if expectations are correct, the ECB could announce its most drastic policy adjustment in years without the yield curve adjusting at all on the date of the announcements. This also means that any cascading effects on other asset classes and macro variables should be expected rather at the time of expectations adjusting, than at the time of the announcement. In such an instance, using a time series of a binary variable coded as 1 on an announcement date and 0 otherwise is ill-suited to accurately quantify the policy announcements. In addition, surprise factors based on yield changes are continuous and can be split into the different dimensions of policy based on the maturity and risk profile of the assets considered for the market response.

The empirical strategy I deploy to identify a sovereign commitment channel can be seen as an extension to that used in previous publications, most notably Gurkaynak et al. (2005)

who to my knowledge are the first to develop a continuous measure of market based monetary policy surprises for the US, Brand et al. (2010) who apply a similar approach to the Euro Area for the first time and most recently Altavilla et al. (2019). While Brand et al. (2010) do not attempt to attribute factors in the data to specific policy surprises and instead simply focus on differential effects on different maturities in the yield curve, Gurkaynak et al. (2005) develop a factor model to disentangle the target dimension from the expected future path of policy. Altavilla et al. (2019) then are able to identify four different factors in Euro Area monetary policy surprises, which they assign to the target rate, forward guidance, quantitative easing and a factor they label timing. While I draw from data from Altavilla et al. (2019), the nearest neighbour to my emprirical strategy in terms of factor extraction is Gurkaynak et al. (2005). The main difference of my investigation compared to the latter is that I focus on Euro Area, not US data, the time period of the Euro Crisis and crucially propose the addition of a novel sovereign commitment factor.

In addition to proposing a measurement of the new sovereign commitment factor, I examine its interaction with sovereign biased balance sheets of banks in Germany, France, Spain and Italy. Under the prior that the sovereign commitment channel affects yields of countries experiencing sovereign debt crises more strongly, I estimate how the balance sheets of representative banks in the four countries are impacted heterogeneously. This is to be expected, given the disproportionate exposure banks tend to have to their own sovereign. Previous investigations into this phenomenon include Marco and Macchiavelli (2016), Horváth et al. (2015), Altavilla et al. (2016) and Saka (2019). Horváth et al. (2015) present evidence of the high level of bias in the exposure to their own sovereign, and further find that this is starker for more risky sovereigns. Saka (2019) further find that this own sovereign exposure increases particularly in periphery countries during the Euro Crisis. Saka (2019) additionally take into account the portfolio size of banks according to a portfolio model, and find that in periphery countries this home bias persists even after this adjustment.

I would also like to point to the relation of this topic to the doom loop literature. One of the main mechanisms of the doom loop, which as a whole is explained well for example by Brunnermeier et al. (2016), is that the value of sovereign debt held by domestic banks plummets in a sovereign debt crisis, which then perpetuates into fewer loans to the economy and lower tax revenues further weakening the sovereigns fiscal strength. It is noteworthy, that the sovereign commitment channel described previously applies exactly to this link in the doom loop: Through commitment to the support of crisis-stricken sovereigns, the assets of these lenders appreciate, potentially offsetting parts of the depreciation due to the sovereigns lowered credit-worthiness.

I find that this interaction between sovereign commitment signalling by the ECB and home bias accounts for stark movements in the valuation of the assets of banks in crisis countries. Thus I add to the exisiting evidence that supports the idea signals along the lines of the one produced by Mario Draghi's "Whatever It Takes" speech at the 2012 Global Investment Conference in London disproportionately benefit lenders in the crisis-stricken

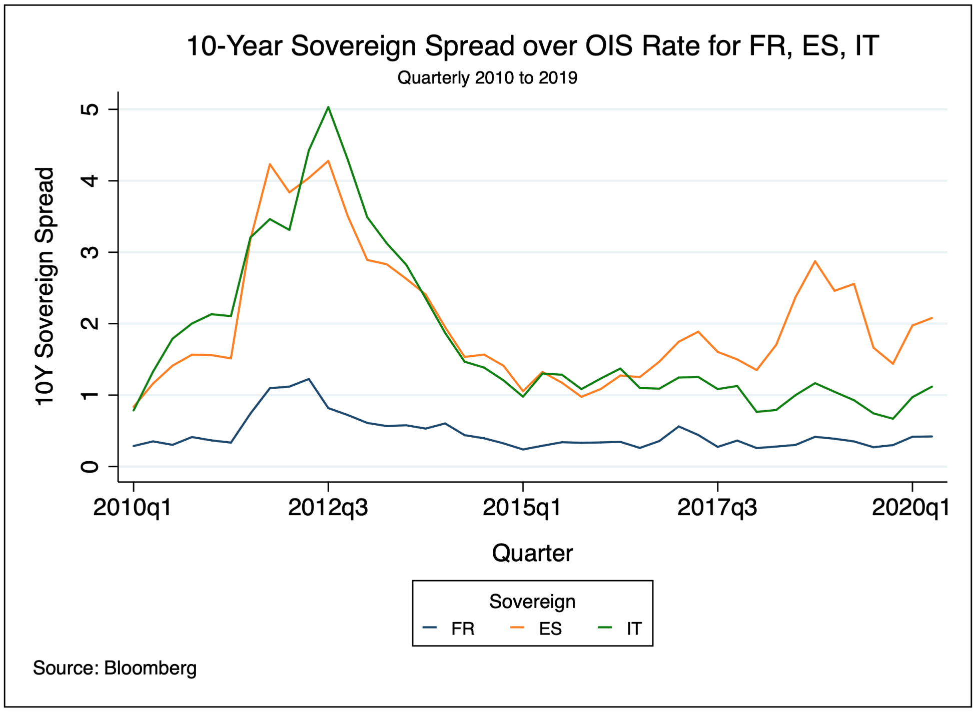

Figure 1: 10-Year Sovereign Spread over OIS Rate for FR, ES, IT

countries.

The remainder of this paper is structured as follows. I first give a detailed account of the data used in the two stages of the paper. The empirical strategy is outlined in section three and the results of the estimation are presented in section four. The final section concludes.

1 Data

I draw from three separate data sources. In stage one of the empirical strategy I use the Euro Area Monetary Policy Event-Study Database (EA-MPD) to identify market based surprise factors from ECB monetary policy announcements. In stage two I utilize sovereign exposure data from a self-compiled data set from European Banking Authority (EBA) as well as from a data set compiled by Bruegel which I enrich with Bloomberg data on sovereign yields.

Euro Area Monetary Policy Event-Study Database

The estimation of the market-based surprise factors of monetary policy announcements is based on the Euro Area Monetary Policy Event-Study Database (EA-MPD) compiled by Altavilla et al. (2019). It provides data for each date on which a monetary policy decision was announced by the ECB since it first took up operations in 1999.

For each date, the change in bond yields is given for three separate time-windows. That is, for each window, the data gives the difference between the yield at the start and the end

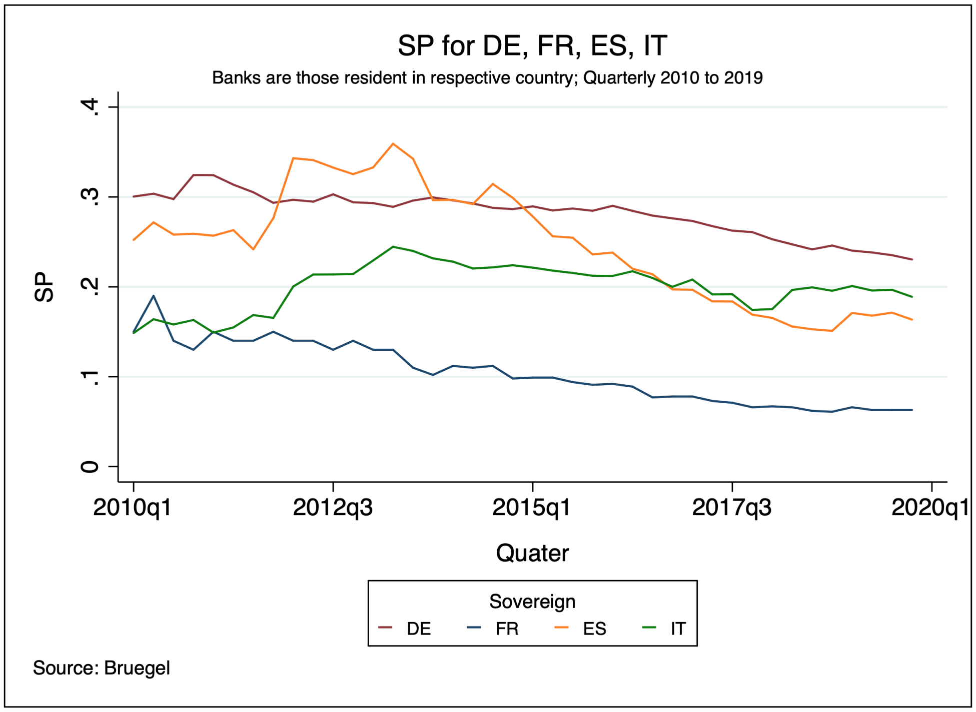

Figure 2: SP for DE, FR, ES, IT

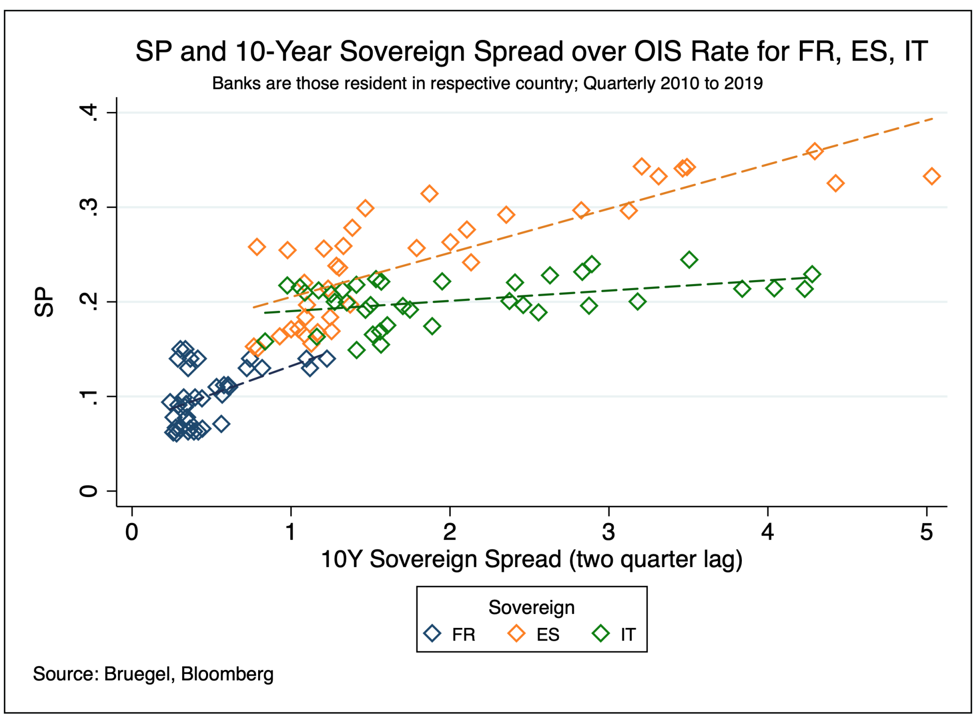

Figure 3: SP and 10-Year Sovereign Spread over OIS Rate for FR, ES, IT

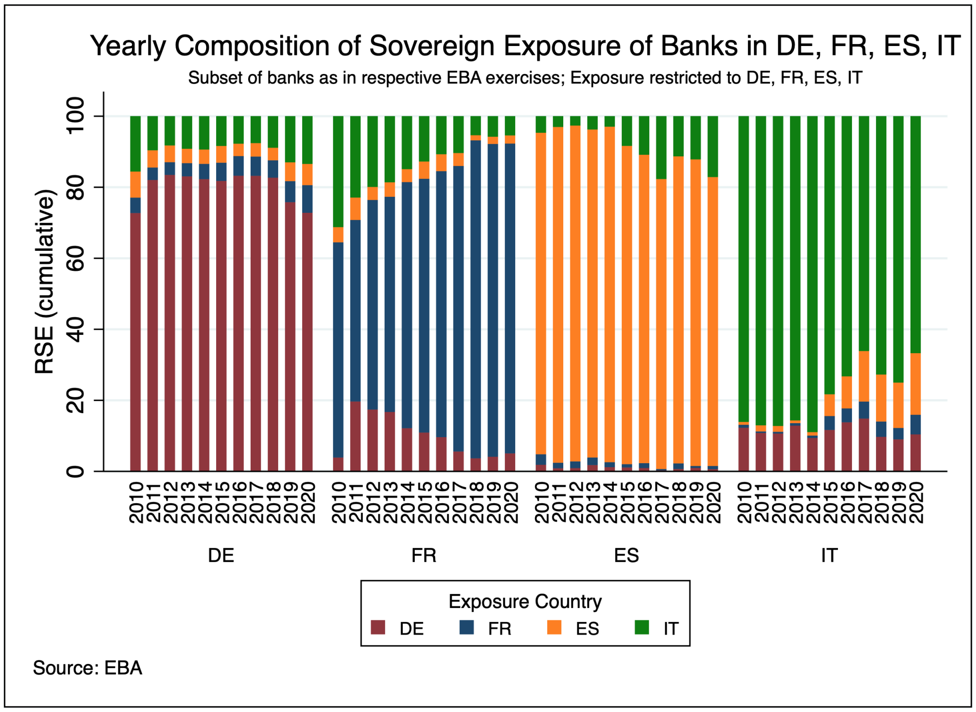

Figure 4: Yearly Composition of Sovereign Exposure of Banks in DE, FR, ES, IT

of the window. There are three windows of interest, as the ECB announces policy in two stages: First, a press release gives a brief overview of the immediate and planned changes to the ECB's policy. The press release is followed by a press conference which serves to provide further detail to the announcements made in the press release and allows journalists to ask questions. Thus the three windows of interest cover the press release only, the press conference only and the whole extend of the monetary event including both press release and press conference, respectively. For the extraction of surprise factors from this data, as described in more depth in stage one of section 3, I deem it most appropriate to consider only the third window described above: This covers the whole monetary event, and thus captures the net response of financial markets obtained from ECB communication on that specific date. While distinguishing between press release and press conference can draw a more nuanced picture and allows more factors to be extracted, as is done by Altavilla et al. (2019), to identify the new sovereign commitment channel the using net response is sufficient. Furthermore, by considering the entirety of the monetary event at once, I avoid confusion resulting from potentially offsetting surprises in the press release and the conference window. All further discussion in this paper is thus concerned with the version of EA-MPD that covers the entire monetary event. I emphasize here that all variables in EA-MPD represent changes over the respective windows, and never levels.

The bonds for which yields are considered are the following: Zero-risk euro area bonds represented by Overnight Index Swap (OIS) rates for maturities of one, three and six months as well as for one, two, five and ten years; Sovereign bonds of maturity two, five and ten years for Germany, France, Spain and Italy. Note that where OIS rates are not available, which for some longer maturities is the case until 2011, I replace it with the corresponding changes of the German bond yields. This replacement is chosen, too, by Altavilla et al. (2019) and is valid as German bonds are widely considered as good as zero-risk (Ejsing et al. (2012). Summary statistics are available in Table 7 in the appendix.

I calculate an additional variable for each of the variables measuring yield changes in French, Spanish and Italian bonds by subtracting from it the variable measuring the OIS rate of the same maturity. The newly created variables thus represent the change in the sovereign spread of the respective country at the respective maturity. In mathematical terms, I define, for country c, maturity m at date t

$$\Delta SPRD_{c,m,t} = \Delta YLD_{c,m,t} - \Delta OIS_{m,t}$$

For the purposes of this paper, I define two data matrices, whose use for estimation will be discussed in the Estimation and Results section. Define for model 1 and model 2 X_1 and X_2, respectively, as follows:

$$\begin{aligned} X_1 =&(\Delta OIS_{1M}, \Delta OIS_{3M}, \Delta OIS_{6m}, \Delta OIS_{1Y}, \Delta OIS_{2Y}, \Delta OIS_{5Y}, \Delta OIS_{10Y}) \\ X_2 =&(\Delta OIS_{1M}, \Delta OIS_{3M}, \Delta OIS_{6m}, \Delta OIS_{1Y}, \Delta OIS_{2Y}, \Delta OIS_{5Y}, \Delta OIS_{10Y}, \\ &\Delta SPRD_{FR,10Y}, \Delta SPRD_{ES,10Y}, \Delta SPRD_{IT,10Y}) \end{aligned}$$

EBA and Bruegel Data

For the second stage of the paper I use two data sources regarding sovereign exposure of European banks. The first is a self-compiled data set using the European Banking Authorities' releases on stress tests, transparency exercises and recapitalisation exercises. The resulting data set is an unbalanced panel of the major banks of each European Economic Area (EEA) country with yearly data from 2010[1] to 2020. The variables contained are the exposure to each EEA country, for eight maturity bands ranging from one year to ten years and over. Due to the heterogeneity of the different exercises conducted by the EBA the number of banks sampled in each year varies between 50 in the 2016 EU Capital Exercise and 115 in the 2018 EU-wide transparency exercise. However, this is not undermining my empirical strategy for the following reason. A balanced panel is not required as I do not perform regressions on the basis of this data. In stage two of section 3, where the EBA data is deployed, I simply project estimates from stage one on the *composition* of the average sovereign exposure of a representative bank in the sample of the respective year. Another shortfall of this compilation is that for 2010 and 2017 a maturity breakdown of sovereign exposure is not available, simply because it was not required by the design of the respective supervisory exercises. For use in the empirical strategy I define a specific measure, which will serve as a proxy to the

[1] While data for 2011 to 2020 is readily available on the EBA website in excel format, the data for 2010 is only available as a PDF and was kindly provided by Orkun Saka, who has previously compiled the same data for his paper Saka (2019)

sovereign exposure of the representative bank in each country. The term representative bank in this paper is used for the *ficticious* bank whose balance sheet is the combined balance sheet of all banks for a country in the sample of a specific EBA exercise. This term will be used throughout this paper. Again, as in stage two of section 2 only relative exposures will be considered the changing composition of the EBA sample over time will be neglected. The new measure I compute gives the amount of sovereign exposure of a representative bank to a country relative to the total combined exposure to Germany, France, Spain and Italy. I term this measure Relative Sovereign Exposure (RSE) of the representative bank in country i to country j. In mathematical terms, write the RSE of country i to country j at time t as

$$RSE_{i,j,t} = \frac{\sum_{b=1}^{N} SovereignExposure_{b,i,t}}{\sum_{b=1}^{N} \sum_{k \in \{DE,FR,ES,IT\}} SovereignExposure_{b,k,t}}$$

where N denotes the number of banks in the EBA sample for country c at time t.

The second sovereign exposure data set is readily available from Bruegel and provides quarterly time series data on sovereign debt levels and what share of that debt is held by domestic banks for a subset of EEA countries, importantly including Germany, France, Spain and Italy. I term the latter metric sovereign portion (SP), which is an extension of the sovereign portion terminology used by Saka (2019). Formally, write the SP of country c in quarter t, where there are N resident banks, as:

$$SP_{c,t} = \frac{\sum_{b=1}^{N} SovereignExposure_{b,c,t}}{SovereignDebt_{c,t}}$$

This data set covers the years 2000 until 2019. While I primarily use the EBA data set, the Bruegel data serves as additional evidence to motivate the stage two empirical strategy. To this end, I further merge to each quarter the average of 10 year sovereign yields for Germany, France, Spain and Italy on the days around the dates where policy announcements were made and which fall into the respective quarter. The latter data is drawn from Bloomberg.

Motivating the Empirical Strategy

I proceed with a discussion of the main patterns emerging from the data. These are crucial to motivate both stages of the empirical strategy which follows. To contextualize the data, note that for the sovereign exposure data, i.e. EBA and Bruegel, the observation period starts in 2010, roughly two years after the global financial crisis of 2008, but right at the onset of the Euro Crisis. Thus, the debt crisis characterized by spiking sovereign yields, which out of the countries in this sample affected Italy most seriously, followed by Spain, falls right within the observation period. There are two developments that make this period interesting for me in answering the question of how the proposed sovereign commitment channel affected banks in crisis-stricken countries disproportionately compared to stable ones.

First, the Euro Crisis was a crisis along various dimensions, however, most notably it

	Sum	Mean	SD	Min
abs(ΔDE10Y)	2.45	0.05	15.89	201.00
abs(ΔFR10Y)	2.66	0.00	18.70	201.00
abs(ΔES10Y)	3.23	0.00	29.30	201.00
abs(ΔIT10Y)	3.69	0.00	45.60	201.00

Table 1: Average yield changes during the monetary event

constituted a sovereign debt crisis. The trust that investors had in the fiscal stability of certain countries, and most notably Greece, Portugal, Cyprus, Slovenia, Ireland, Italy and Spain manifested in spiking sovereign spreads (Figure 1). This crucially left room for policy makers, both fiscal and monetary, to signal commitment to guaranteeing sovereign solvency. In the solely monetary context of this paper, this motivates the existence of a sovereign commitment channel in the ECB's policy announcements. Clearly, it should be expected that this channel affects mostly countries in crisis. Indeed, the EBA data show that the average change in Italian and Spanish yields during the monetary events are considerably higher than those of France and Germany (Table 1). This means that in addition to the effect on the zero-risk yields, an additional factor drives sovereign spreads through changing market perceptions of sovereign risk. This motivates the first stage of the section 2: Identifying a sovereign commitment channel in the market reaction to ECB policy announcements.

Second, the debt crisis also coincided with an increase in SP in many crisis countries. This means that the portion of a sovereigns debt held by banks resident in that country increased starkly. This does not mean that the SP of a crisis country was necessarily higher than for a country not severely affected by the crisis, but that it rose above the pre-crisis SP of that country (Figure 2). In particular, for each of France, Italy and Spain the level of sovereign portion is positively correlated with the 10-year sovereign spread vis-a-vis the corresponding OIS rates (Figure 3). The literature suggests that this phenomenon of increased sovereign bias is not coincidental, but rather a result of the uncertainty surrounding the credit worthiness of the particular sovereign: Some authors (Marco and Macchiavelli (2016);Horváth et al. (2015);Altavilla et al. (2016)) argue that countries tend to have a degree of moral suasion power over their domestic banks to induce them to take up sovereign debt, while others (Saka (2019)) find evidence that it is a result of information frictions. To simplify the latter notion, one can consider for instance an Italian bank that, due to sharing a language with their sovereign and overall having more precise insight into the actual fiscal, political and economic situation of Italy, is able to judge the default risk more precisely making them less hesitant to take up debt. For the context of this paper, this increased SP implies that changes in the valuation of this debt affects balance sheets of domestic banks more than it would have pre-crisis. The reason for the increased SP will not be discussed in more depth and the interested reader is referred to the related literature.

That said, I now shift the focus from the debtor perspective to that of the creditor. To this end, we consider the EBA data, for which we consider the RSE measure as defined above

(Figure 4). First I emphasize the overwhelmingly dominant RSE representative banks have to their own sovereign. In 2012, at the height of the sovereign debt crisis, I find that that the $RSE_{DE;DE}$, $RSE_{FR;FR}$, $RSE_{ES;ES}$ and $RSE_{IT;IT}$ stand at 83.5%, 59.0%, 94.5% and 87.2% respectively. For each of Germany, Spain and Italy this is among the two highest values over the ten year sample period. For these countries, we also see that the 2010 RSE of the representative bank to its own sovereign is lower by 9.2%, 4.5% and 1.1% percentage points respectively. The exception is France: In 2012 the RSE of its representative bank, with 59.0%, stands at its second lowest level. I further observe that the RSE of the representative banks of the core countries France and Germany to Italy follows a downward trend during the main crisis period 2010 to 2014. In Spain, too, the RSE of the representative bank to Italy is at a very low level during this four year period. Except for France, we see that towards the end of the 2010s the relative exposure of representative banks diversifies, coinciding with the easing of the debt crisis which manifests itself in the return of crisis country 10-year yields to lower levels (Figure 1). To summarize, own sovereign RSE is consistently high for all countries in the sample and peaks during the debt crisis for all countries except France. This motivates the stage two of the section 2: Projecting the estimated effect of the surprise factors on the representative balance sheet of banks in the four countries. This enables me to evaluate whether banks in crisis countries profit disproportionately from sovereign commitment of the ECB.

2 Empirical Strategy

As outlined previously the empirical strategy consists of two stages. In the first stage I deploy a principal component analysis to extract the different dimensions of the monetary policy announcements from the EA-MPD database. This will yield a time series of each of the dimensions with datapoints for each of the policy announcement dates. I then regress the changes in bond yields for each of the four european countries covered in the EA-MPD onto the factors to obtain estimates of the sensitivity of each of the bonds to each dimension. I then, in a second stage, interact these coefficients with the exposures of banks to each of the countries.

Stage 1: Factor Estimation

In this section I describe the methodology used to extract the market based factors at play during the ECB announcements. I discuss two models, which use distinct subsets of the EA-MPD data and are based on different identification strategies in attributing dimensions of the ECB's policy to the factors. However, the three step process by which the models are estimated are the same: In a first step, I use a principal factor analysis algorithm, which is based on iterative eigenvalue decomposition of the correlation matrix of the underlying data. This is chosen as it provides more interpretable results compared to maximum likelihood methods according to Revelle (2021). It is one of various methods of factor analysis, which seeks to explain the underlying observed data by unobserved latent factors Revelle (2021). Importantly, the number of latent factors is lower than the number of variables in the underlying data. This is appropriate in the setting of this paper, as the number of assets the yield changes of which we observe is believed to be strictly greater than the number of dimensions of monetary policy. Let $\underset{n\times k}{X}$ be the data underlying the model at hand, with n rows i.e. dates and k columns i.e. yield change variables. The factor model represents X as follows:

$$X = F\Lambda$$

where $\underset{n\times k}{F}$ represents the k selected factors extracted using principal factor analysis and $\underset{k\times k}{\Lambda}$ represents the loadings such that their product equals X. In a second step I deploy a Kleibergen-Paap rank test to determine the number of significant factors to retain. To this end, I successively test the null hypothesis that the matrix of the first m factors with the remaining $m - n$ factors is full column rank, starting with $m = 1$ and increasing in unit steps, until the hypothesis $H_0 = m$ is rejected. This test, as opposed to the Cragg-Donald test employed by Altavilla et al. (2019) is heterosketasticity robust (Paap and Kleibergen (2004)). Let the result from this rank test for the model at hand be m. Then, retaining only the first m factors and their corresponding loadings, X is now represented by

$$X = F_m\Lambda_m + \epsilon \tag{1}$$

where $\underset{n\times m}{F_m}$ is the matrix of remaining factors, $\underset{m\times m}{\Lambda_m}$ are the corresponding loadings and ϵ is the residual of the model. In a last step I perform a factor rotation to make the factors interpretable in the monetary policy setting. The rotation is obtained by multiplying the factors by a orthogonal matrix $\underset{m\times m}{\Sigma}$. This rotation matrix is the result of a constrained optimisation problem where both the constraints and the objective function result from the intended interpretation of the resulting rotated factors, $F^* = F_m\Sigma$. This optimisation problem is model specific, and further depends on the dimension m of Σ. Inserting $\Sigma\Sigma^{-1} = \Sigma\Sigma'$ in Equation 1 above illustrates that the new loadings matrix is $\Lambda^* = \Sigma'\Lambda_m$. The predicted values, and so the residual, of the model remain unchanged as $\Sigma\Sigma' = I$. We have:

$$\begin{aligned} X &= F_m\Sigma\Sigma'\Lambda_m + \epsilon \\ &= F^*\Lambda^* + \epsilon \end{aligned}$$

As the method for principal factor decomposition and the set-up of the rank test are the same in both models, the following paragraphs focus only on parts of the models where their structure varies, which especially regards the optimisation problem deployed in the rotation and the economic reasoning behind it. The optimisation set-up in model 1 will aim to disentangle the target rate dimension from the dimension of unconventional policy

H_0	Chi-sq	p-value
0	27.14	0.0074
1	17.94	0.0064
2	5.17	0.0756

Table 2: Kleibergen-Paap: Model 1

(capturing both forward guidance and quantitative easing). The optimisation in model 2 will add one additional dimension to describe the sovereign commitment channel discussed previously. In principle, the respective constraints and objective function are non-unique but are chosen to ensure the rotated factors load on specific yields, i.e. long vs short maturities or zero-risk vs risky assets.

Model 1: Based on OIS Rates

The first model represents the family of models used hitherto in the existing literature on market based measures of monetary policy in the sense that it is estimated solely on the basis of OIS rates, which as outlined in the data section, represent yields on zero-risk sovereign bonds in the euro area. The purpose of this model is to demonstrate that measuring monetary policy on the basis of market reactions of zero-risk assets is ill-suited to explain yield movements in other risky sovereign debt. While measurement on the basis of zero-risk assets seems appropriate in the case of the US or the UK, where the central bank is operating on a national scale only and sovereign default risks are negligible, the economic and fiscal heterogeneity of the Euro Area requires a more nuanced measurement. As defined in the Data section, I estimate the model on the X_1 data matrix.

Of the extracted factors two are retained following the Kleibergen-Paap rank test, the results of which are presented in Table 2. Thus F_1 is $n \times 2$ and Σ_1 is 2×2 and the optimisation problem we set up to determine the rotation matrix is one in four unknowns. Three binding constraints are specified by the requirement for Σ to be orthonormal. To impose the economic interpretation that unconventional monetary policy, i.e. forward guidance and quantitative easing, does not affect short term rates, we set the objective function to be the loading of the second factor on the one month rates. The resulting optimisation problem is the following, where for a matrix X the subscript X_{ij} denotes the entry in the ith row of the jth column, $X_{.j}$ refers to the vector constituting the jth row and $X_{i.}$ refers to the vector constituting the ith column of X:

$$\underset{\Sigma}{argmin}\{\Sigma'_{2.}\Lambda_{.1}\}$$
$$s.t.\ \Sigma\Sigma' = I$$

Model 2: Based on OIS Rates and Sovereign Spread

The second model now is designed to incorporate default risk in addition to the zero-risk OIS rates. This is a clear departure from existing literature on measuring euro area monetary policy. It is achieved by including the changes in spread of French, Italian and Spanish ten year bonds vis-a-vis the German equivalent, where as previously stated the German bonds are generally considered zero-risk. The restriction to the subset of France, Italy and Spain is due to data constraints of the EA-MPD, as stated in the Data section. Given that with Germany these are the four largest economies in the EU and consist of both core (Germany, France) and periphery (Italy, Spain) countries which were suffering different degrees of sovereign stress during the Euro Crisis I believe this is fairly representative of the dynamic and heterogeneuos default risk profile within the Euro Area. I include ten year bonds only, as the spread should be solely representative of the sovereign default risk, so the additional value of including other maturities is limited while it complicates the identification of the rotation matrix. This model uses data matrix X_2 for the factor extraction.

Of the extracted factors three are retained following the Kleibergen-Paap rank test, the results of which are presented in Table 3. Thus $m = 3$ and so F_m is $n \times 3$ and Σ_m is 3×3. This model hence requires the determination of nine unkowns. Again, the orthonormality requirement on Σ gives six binding constraints. As in model 1 I require the second factor to not load on the one month rates to ensure its interpretability as unconventional policy dimensions. To make the newly emerging factor, whose existence has been suggested by the rank test, interpretable as the sovereign commitment dimension, I set the eighth constraint to ensure the third factor does not load on the ten year *zero-risk* rates. The rationale for this is that an announcement by the ECB that reiterates its commitment to a stable monetary union through preventing sovereign defaults should influence only the sovereign default probability and not the predicted target rate 10 years in the future. Thus, the factor should only affect the differential in yields induced by sovereign default risk, i.e. the spreads of FR, ES and IT. Following the same reasoning, I set the objective function to be the squared sum of loadings of the sovereign commitment factor on all other maturities. The optimisation problem then becomes:

$$\begin{aligned} &\underset{\Sigma}{argmin}\{\sum_{t=1}^{6}\Sigma'_{3.}\Lambda_{.t}\} \\ s.t. \quad &\Sigma\Sigma' = I \\ &\Sigma_{2.}\Lambda_{.1} = 0 \end{aligned}$$

where t denotes columns of the data matrix X_1, which are the different maturities (and 10-year sovereign spreads of France Spain and Italy for $t \geq 8$).

H_0	Chi-sq	p-value
0	54.01	0.0004
1	35.21	0.0023
2	25.30	0.0014
3	5.66	0.1294

Table 3: Kleibergen-Paap: Model 2

Goodness of Fit and Model Selection

The motivation for including sovereign spreads in model 2 as opposed to restricting the data to OIS rates has already been touched on in the previous model subsections. However, to motivate the step from model 1 to model 2 I want to draw on empirical evidence, too. To this end, I regress the bond yield changes of Germany, France, Italy and Spain on the target (TG) and unconventional (UC) factors from the rotated factor decomposition. To be able to judge the R^2 statistic on country level and across maturities, I transform the country level yield change variables (two-year, five-year and ten-year) from wide to long, introducing a factor variable that carries the maturity of each yield change. The resulting data set is a panel of yield changes of three maturities per date. To this I merge (many to one) the model two surprsie factors. I run the following regression seperately for country $c \in \{DE, FR, ES; IT\}$, where D_y with $y \in \{2y, 5y, 10y\}$ is a maturity dummy:

$$\begin{aligned}\Delta Y_{c,t} = & \alpha_{c,2y} + \alpha_{c,5y} D_{5y} + \alpha_{c,10y} D_{10y} \\ & + (\beta_{c,2y} D_{2y} + \beta_{c,m} D_{5y} + \beta_{c,m} D_{10y}) TG_t \\ & + (\gamma_{c,2y} D_{2y} + \gamma_{c,5y} D_{5y} + \gamma_{c,5y} D_{10y}) UC_t \\ & + \varepsilon_{c,t}\end{aligned} \tag{2}$$

The results of this estimation will be presented in the Estimation and Results section, making the case for the use of model 2. For model 2, we repeat this exercise, now incorporating the new sovereign commitment (SC) factor. The regression equation becomes:

$$\begin{aligned}\Delta Y_{c,t} = & \alpha_{c,2y} + \alpha_{c,5y} D_{5y} + \alpha_{c,10y} D_{10y} \\ & + (\beta_{c,2y} D_{2y} + \beta_{c,m} D_{5y} + \beta_{c,m} D_{10y}) TG_t \\ & + (\gamma_{c,2y} D_{2y} + \gamma_{c,5y} D_{5y} + \gamma_{c,5y} D_{10y}) UC_t \\ & + (\delta_{c,2y} D_{2y} + \delta_{c,5y} D_{5y} + \delta_{c,5y} D_{10y}) SC_t \\ & + \varepsilon_{c,t}\end{aligned} \tag{3}$$

The estimates from this will be instrumental for the projections made in stage two of the empirical strategy. It should be noted however, that the improvement in fit from model 1 to model 2 is not coincidental, but simply due to the fact that the estimated factors in model 2 include information on the sovereign spreads. It makes little sense in this instance to speak of causality, as the measures of monetary policy is based in part on the outcome variables or linear combinations (in case of spread) thereof. It should be seen rather as a variance decomposition.

Stage 2: Balance Sheet Projection

In this second stage I use the factor decomposition from stage one to project the effect of the different factors of monetary policy surprises onto the balance sheet of the representative banks in the four countries under consideration. The pattern of sovereign bias which experiences an additional increase in the periphery countries Spain and Italy during the crisis have been discussed in the Data section and motivate this step.

First, I outline in what way I simplify the balance sheet structures. Considering all asset classes and the way each is affected by ECB announcements goes beyond the scope of this paper. Instead I focus only on the relative exposures that the representative bank has to these four countries, making use of the RSE measure introduced in the Data section. By this method it is possible to compare the impact that the surprise factors of monetary policy have on the representative balance sheet in each of the countries. This gives meaningful results under the limiting assumption that the remainder of the representative balance sheets, that is all assets that are not German, French, Spanish or Italian sovereign debt, reacts to the factors in a comparable way – or, *ceteris paribus*. Testing this assumption is beyond the scope of this paper, due to limited availability of data on precise balance sheet composition and lack of access to high frequency data on most assets.

As from the estimated regression based on Equation 3, we only get coefficients for two-year, five-year and ten-year maturities, I choose to collect the maturity bands from the EBA data into three bins: Maturities up to four years (2Y bin), maturities greater than four and up to ten (5Y bin) and maturities greater than ten years (10Y bin). This split is to some degree arbitrary, however this is the highest degree of granularity the data allows. Within each bin, I sum up the sovereign exposure to each country. I now define a bin level RSE precisely as above, but simply restricting exposures to the maturities in the k bin, so that the $RSE_{i,j,t,k}$ is the relative sovereign exposure of the representative bank in country i to country j at time t where only exposures to bonds in the maturity range of the k bin are considered.

For the sake of an example, consider only the k bin. The below equation shows how the interactions of RSE and country specific estimated $\hat{\beta}_{c,k}$, $\hat{\gamma}_{c,k}$ and $\hat{\delta}_{c,k}$ coefficients jointly determine the balance sheet impact. Denote the overall balance sheet effect from the monetary event on the representative bank of country c on date t by $E_{total,c,t,k}$, and in the same manner the effects of target, unconventional policy and sovereign commitment surprises by

$E_{TG,c,t,k}$,$E_{UC,c,t,k}$,$E_{SC,c,t,k}$.

$$\begin{aligned}
E_{total,c,t,k} =& E_{TG,c,t,k} + E_{UC,c,t,k} + E_{SC,c,t,k} \\
=& F_{TG,t} \times \boldsymbol{\hat{\beta}_k}'\boldsymbol{RSE_{c,t,k}} + F_{UC,t} \times \boldsymbol{\hat{\gamma}_k}'\boldsymbol{RSE_{c,t,k}} + F_{SC,t} \times \boldsymbol{\hat{\delta}_k}'\boldsymbol{RSE_{c,t,k}} \\
=& \boldsymbol{F_t'} \times \boldsymbol{W_{c,t,k}}
\end{aligned}$$

where

$$\boldsymbol{\hat{\beta}} = \begin{pmatrix} \hat{\beta}_{DE,k} \\ \hat{\beta}_{FR,k} \\ \hat{\beta}_{ES,k} \\ \hat{\beta}_{IT,k} \end{pmatrix}, \boldsymbol{\hat{\gamma}} = \begin{pmatrix} \hat{\gamma}_{DE,k} \\ \hat{\gamma}_{FR,k} \\ \hat{\gamma}_{ES,k} \\ \hat{\gamma}_{IT,k} \end{pmatrix}, \boldsymbol{\hat{\delta}} = \begin{pmatrix} \hat{\delta}_{DE,k} \\ \hat{\delta}_{FR,k} \\ \hat{\delta}_{ES,k} \\ \hat{\delta}_{IT,k} \end{pmatrix},$$

$$\boldsymbol{RSE_{c,t,k}} = \begin{pmatrix} RSE_{c,DE,t,k} \\ RSE_{c,FR,t,k} \\ RSE_{c,ES,t,k} \\ RSE_{c,IT,t,k} \end{pmatrix}, \boldsymbol{F_t} = \begin{pmatrix} F_{TG,t} \\ F_{UC,t} \\ F_{SC,t} \end{pmatrix}, \boldsymbol{W_{c,t,k}} = \begin{pmatrix} \boldsymbol{\beta_k'} \\ \boldsymbol{\gamma_k'} \\ \boldsymbol{\delta_k'} \end{pmatrix} \boldsymbol{RSE_{c,t,k}}$$

Note how the RSEs of country c to each of the four countries in the sample function as a weighting of the effects induced by the factors. Note further, that if

$$RSE_{c,DE,t,k} = RSE_{c,FR,t,k} = RSE_{c,ES,t,k} = RSE_{c,IT,t,k} \;\; \forall\, c \in \{DE, FR, ES, IT\},$$

then

$$E_{total,DE,t,k} = E_{total,FR,t,k} = E_{total,ES,t,k} = E_{total,IT,t,k}.$$

Economically, if representative banks in the four countries share the same RSE for the k bin, or of course if there entire portfolio identical, then despite the sovereign commitment channel affecting bonds of crisis-stricken countries more, balance sheets will not react heterogeneously. Note that in the calculation I ignore the constant terms α of the regression as they have no reasonable interpretation in the context and Table 5 will further show that they are not significantly different from zero at the 5% significance level.

Thus to learn about the balance sheet affect on the representative bank of country c at time t I need to calculate $W_{c,t,k}$ for c in $\{DE, FR, ES, IT\}$ and k in $\{2Y, 5Y, 10Y\}$. Define the bin proportion (BP) of the k bin for the representative bank in country c at time t as follows:

$$BP_{c,t,k} = \frac{k\ Bin\ Total}{\sum_{k \in \{2Y,5Y,10Y\}} k\ Bin\ Total}$$

Given a policy surprise $\boldsymbol{F_t}$ the maturity adjusted balance sheet effect $E_{total,k}$ can then simply be calculated as:

$$E_{total,c,t} = \sum_{k \in \{2Y,5Y,10Y\}} E_{total,c,t,k} \times BP_{c,t,k}$$

In the section 3 section I will demonstrate this for the year 2012, when the the Euro Crisis was at its height for an average policy shock $\boldsymbol{F_{avg}}$ and other scenarios. I would like to stress here, that due to the data limitations discussed in the Data section and further simplifying assumtions that have to be made the following calculation should be regarded as a back of the envelope calculation, rather than a precise estimate.

3 Estimation and Results

In this section I turn to the estimates obtained from the factor models described in the Empirical Strategy section and present their balance sheet projections.

Stage 1: Factor Estimation

Note that in the following that for interpretability purposes, factors and loadings have been normalized. Target and unconventional policy factor have been normailized by its maximum loading, so that the peak loading has unit value. The sovereign commitment factor has been normalized by the average loading on the factor has on the French, Italian and Spanish sovereign bond spreads. Furthermore, the sign of the factors is adjusted to ensure the target factor correlate positive with the one-month OIS rate changes, the unconventional factor correlates positively with the five-year OIS rate changes and the sovereign commitment factor correlates positively with the ten-year sovereign spread changes of France, Italy and Spain. For the interpretation this means that a positive surprise factor equals a contractionary monetary surprise – recall however that this does not necessary mean the announcement is of contractionary policy, just that it falls short of expectations.

Model 1: Factors

The rotated loadings matrix, Λ^*, is illustrated in Figure 5. Evidently, the optimisation problem has delivered the intended interpretation of the resulting rotated factors. The loading of the target rate factor has on the different terms of the yield curve peaks at the shortest one year maturity and then levels off reaching zero at the ten year term. Due to the minimization of the unconventional factor's loading on the short term rates, the unconventional factor does not load on short term rates and gradually increases to peak at the five year maturity and falling slightly towards the long end of the yield curve. This is reasonable, as this unconventional factor should capture both forward guidance, the influence of which is said to peak in the medium short term, and quantitative easing, which targets the long end of the yield curve (Brunnermeier and Reis (2019)). The time series (Figure 6) tracks the factors over from 2002 to 2020. Evidently, the largest spikes in the surprise measure occur during the period of the global financial crisis of 2008 and into the Euro crisis of the mid 2010s. This is expected, due to increased uncertainty about monetary policy during that time. Note in particular, that the unconventional policy surprises spiked considerably on 5th June and 3rd July 2008. This is around the time when quantitative easing first entered the policy space through its deployment by the Federal Reserves Bank in the US (Böhl et al. (2020)). It is reasonable to assume that the possibility of quantitative easing has caused considerable volatility in expectations and, importantly, potential for the ECB to defy expectations.

Model 1: Goodness of Fit

Table 4 shows the estimates for Equation 2. I will discuss them only shortly, focusing mostly on why model 1 seems inappropriate to capture monetary policy effects across risk-profiles. As would be expected given the shortest maturity considered is two years, all coefficients for the unconventional policy factor are significantly different from zero. Furthermore, the coefficients on the target factor are not significantly different at the 1% significance level either. Again, this is reasonable given the target factor is designed to capture the latent factor driving short term zero-risk rates. What is striking is the goodness of fit discrepancy between the core countries of Germany and France and the periphery countries of Spain and Italy. While the R^2 coefficient is well above .8 for both Germany and France, it drops to .37 for Spain and .25 for Italy. Similarly, standard errors of the estimates skyrocket when moving from Germany, where standard errors are about .05 for all estimates, to Italy, for which all estimates exhibit standard errors well beyond .1. Note that the letter is sizeable in comparison to the estimates. Clearly the response of sovereign yields of countries affected adversely by the debt crisis is not captured well by the model.

Model 2: Factors

The rotated loadings matrix, Λ^*, for this model is illustrated in Figure 7 and Figure 8. Cleary, the optimisation that solves for the rotation leaves little room for target and uncoventional to adopt a different term structure. The minimisation of the loadings of the third factor on the OIS rates appears to have been affected very little by the constraints imposed, loadings on the zero-risk yield changes are almost zero at all maturities. This means that it is permissible to label this third factor with the sovereign commitment dimension. Indeed, this labelling is reinforced by the loadings this factor has on the changes in French, Spanish and Italian ten year sovereign spreads (Figure 8). Notably – and this is true also before normalization of loadings as described above – the sovereign commitment factor is the factor loading most strongly on the spreads. The fact that the loadings are of similar magnitude

	(1)	(2)	(3)	(4)
VARIABLES	DE	FR	ES	IT
$D_{10Y}\#TG$	-0.111**	0.0126	0.0683	0.239
	(0.0510)	(0.109)	(0.155)	(0.318)
$D_{5Y}\#TG$	0.199***	0.369***	0.218	0.419
	(0.0400)	(0.0950)	(0.132)	(0.303)
$D_{2Y}\#TG$	0.529***	0.657***	0.463***	0.529**
	(0.0378)	(0.0619)	(0.129)	(0.229)
$D_{10Y}\#UC$	0.775***	0.771***	0.611***	0.597***
	(0.0549)	(0.0715)	(0.0978)	(0.123)
$D_{5Y}\#UC$	1.104***	1.068***	0.801***	0.832***
	(0.0269)	(0.0481)	(0.0827)	(0.104)
$D_{2Y}\#UC$	1.133***	1.082***	0.852***	0.888***
	(0.0539)	(0.0532)	(0.0938)	(0.108)
Constant	0.0172	-0.146**	-0.291*	-0.177
	(0.0491)	(0.0715)	(0.160)	(0.221)
Observations	603	603	603	603
R-squared	0.916	0.832	0.373	0.250

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Model 1: Regression

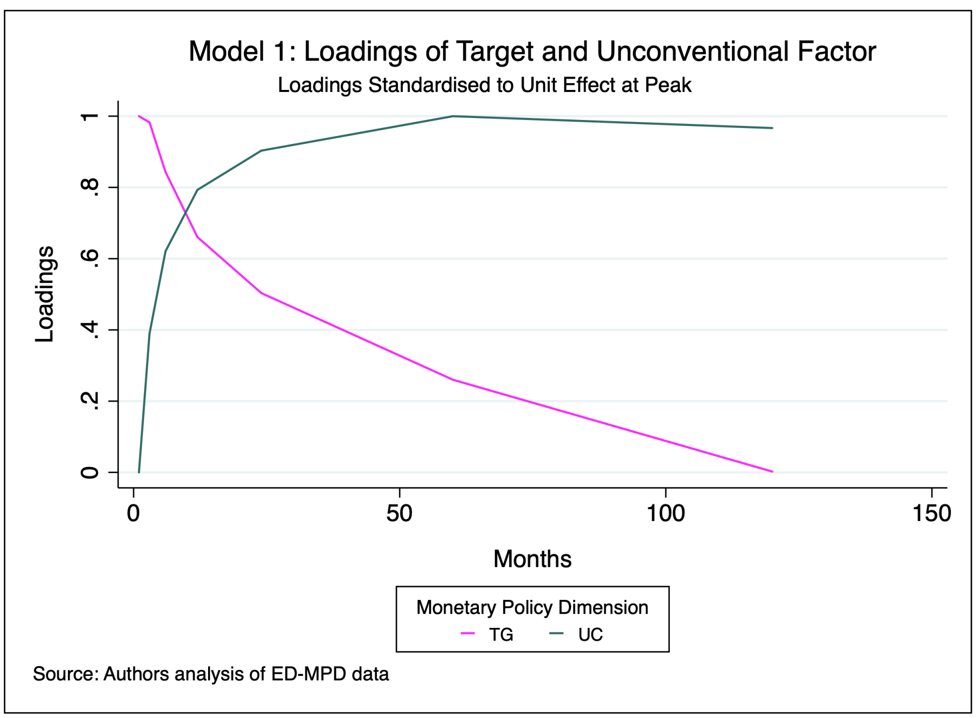

Figure 5: Model 1: Loading on OIS rates

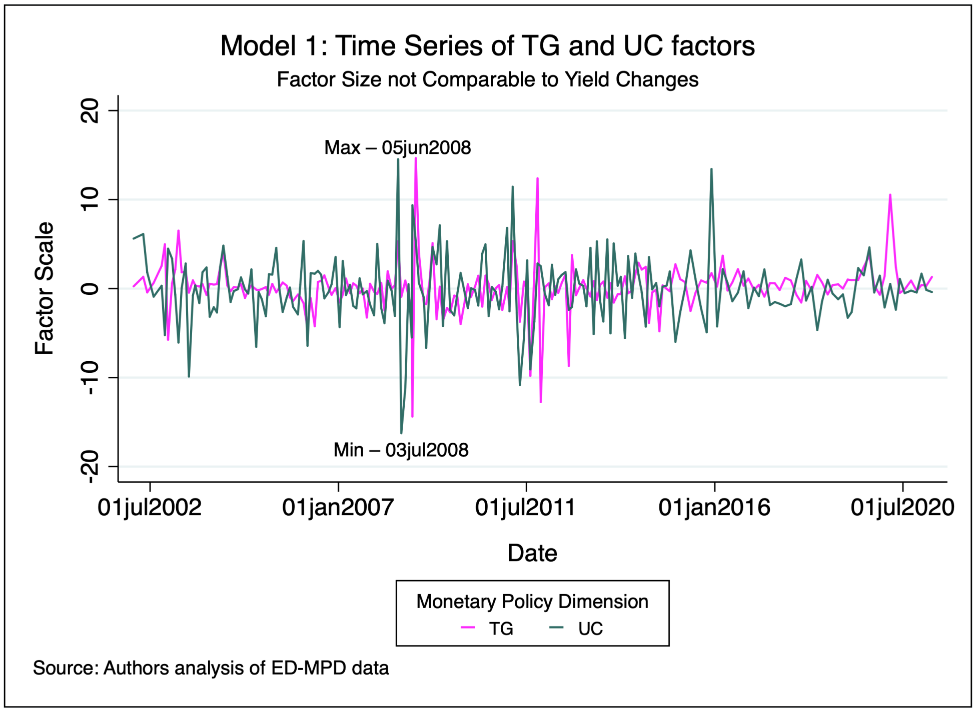

Figure 6: Model 1: Time Series of Extracted Factors

Figure 7: 10-Year Sovereign Spread over OIS Rate for FR, ES, IT

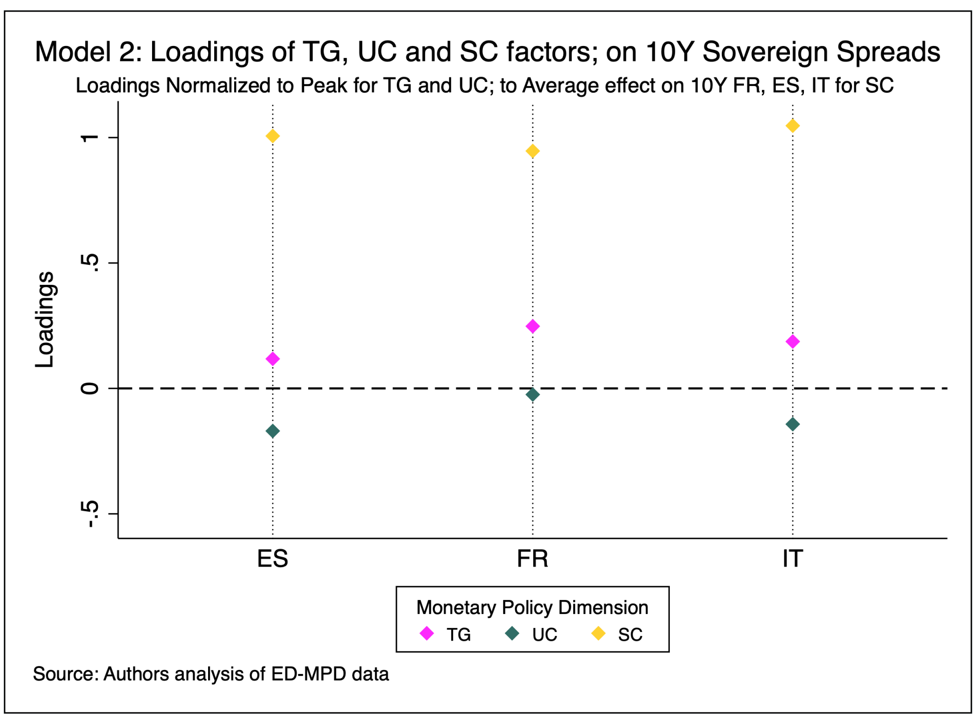

Figure 8: Model 2: Loading on Sovereign Spreads

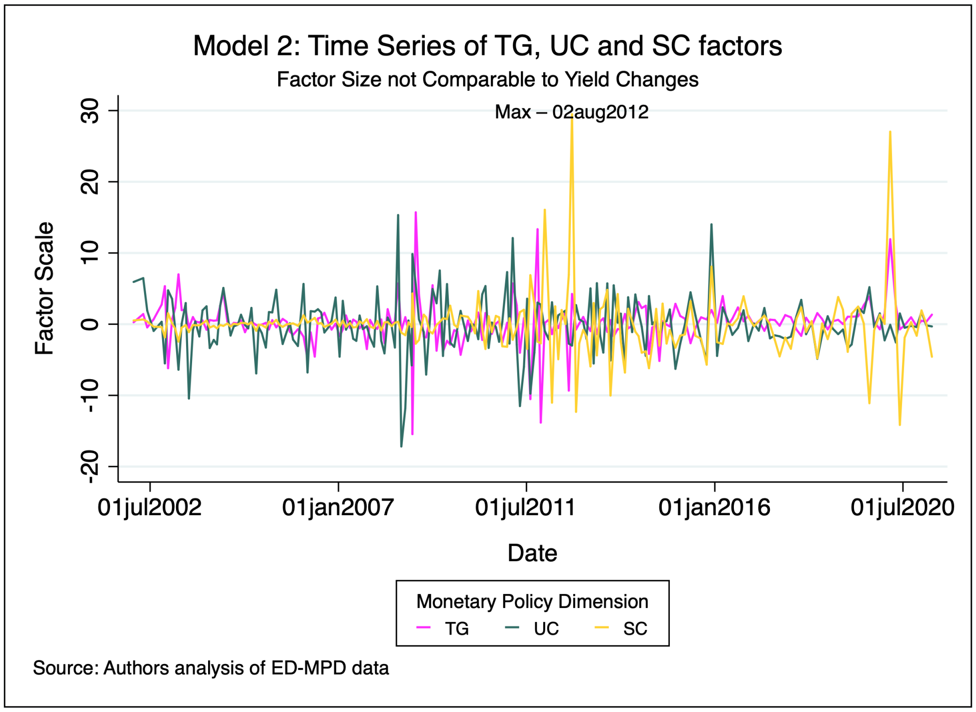

Figure 9: Model 2: Time Series of Extracted Factors

across the countries further should be expected, as the ECB does not have a mandate to deploy country specific policy measures. Still, within the margin that the loadings differ for the three countries Italy scores the highest and France the lowest, consistent with the severity of the debt crisis (Figure 1). Furthermore, the target factor, too, exhibits a fairly strong loading coefficient of around a quarter of the size of that for the sovereign commitment factor. The reason for this however, cannot be identified with certainty, however one can speculate that a surprise contractionary rate hike, is judged by investors to increase sovereign stress as it increases the cost of refinancing. Lastly, it should be noted that the loading of the unconventional policy surprise factor is negative albeit small. While for the French sovereign spread it is close to zero, it sits at around 0.2 for Spain and Italy. This can be seen as a sign that the unconventional policy that accounts for movement in the risk-free yields is a complement to the sovereign commitment channel which drives the differential changes for risky assets. This could easily be an outcome of the method of measurement employed here: OIS rates might change when markets expect the ECB to extend purchases of zero-risk assets, while sovereign yields of periphery countries might change if markets expect purchases of debt from crisis-stricken countries rather than zero-risk ones. Thus, a complementarity of the two channels is not implausible.

Lastly, the time series of the three factors is depicted in (Figure 9). As one would expect given the similarity of the loadings for the target factor and the unconventional factor between the two models, their timeseries appear widely identical. What is interesting to see is how the sovereign commitment factor spikes out during the early 2010s, i.e. during the height of the Euro Crisis, and again in 2020 when we also observe a heightened sovereign spread for Italy (Figure 1). The largest spike appears on 2nd August 2012, just a week after Mario Draghi's famous "Whatever It Takes" speech. This is a beautiful example of how the surprise channel works for sovereign commitment: After the speech no doubt financial markets had heightened expectations about the ECBs commitment to maintaining a stable monetary union. The extreme spike just six days later however was a signal of a contractionary surprise, as it is in the positive domain of the factor. This means that the policy announcement on 2nd August 2012 fell short of what investors expected in terms of sovereign commitment. Interestingly, the same date records an unconventional surprise of -3. This leads us back to the statement made earlier, about how the two factors could be complementary. The interpretation in this specific case could be that investors were expecting unconventional measures targeted specifically at the crisis-countries. However, given the lack of a mandate to target specific countries, the actual response was a more broader measures targeting the block as a whole, which lead to a expansionary surprise in the measure of the unconventional policy factor that is measured mainly from zero-risk assets. Altavilla et al. (2019) state as a limitation that their quantitative easing surprise, which as well is measured only on OIS rates, should be considered a "macroeconomic QE". They point to Rogers et al. (2014) who indeed include sovereign risk premia in their measurement of market reactions, however they do not deploy a principal factor model to disentangle the different dimensions as I do.

Model 2: Goodness of Fit

I now turn to the estimates of Equation 3, shown in Table 5. I first note that while coefficients on the target and unconventional surprise factor differ from those found for model 1, the order of magnitude is the same for both models. However, the estimates are much more precise, with all standard errors below .1. Thus, for Spain and Italy the coefficients on the target factor for the longer maturities are now significantly different from zero, despite the estimates being of roughly similar size to model 1. Most importantly, the R^2 statistics for Spain and Italy now stand at 0.8 and 0.88 respectively and have more than doubled compared to the fit of model one. While the differences in the estimates for the target surprise show no clear pattern between core and periphery countries, the unconventional policy factor is associated with a starker change in the sovereign yields of Germany and France across all three maturities. On the other hand, naturally, the sovereign commitment factor is associated much more strongly with Spanish and Italian yields. In fact, the coefficient on the sovereign commitment factor for Germany is insignificant at all maturities. This is no surprise, as German bonds are generally considered zero-risk and thus there is no variation in the default risk that could potentially be explained by the ECB's sovereign commitment. Overall, model two seems well suited to attribute variation of bond yields to the dimensions of the ECBs policy surprises, even for countries in the periphery. I would like to stress here that the improvement in the variation explained from model 1 to model 2 is not at all obvious: One could have suspected that the stronger variation in the periphery country yields during the

	(1)	(2)	(3)	(4)
VARIABLES	DE	FR	ES	IT
$D_{10Y}\#TG$	-0.0979**	0.00800	0.0284	0.181***
	(0.0469)	(0.0640)	(0.0821)	(0.0662)
$D_{5Y}\#TG$	0.188***	0.340***	0.172**	0.345***
	(0.0373)	(0.0630)	(0.0864)	(0.0798)
$D_{2Y}\#TG$	0.493***	0.611***	0.408***	0.457***
	(0.0363)	(0.0520)	(0.140)	(0.0935)
$D_{10Y}\#UC$	0.732***	0.729***	0.576***	0.564***
	(0.0521)	(0.0612)	(0.0478)	(0.0556)
$D_{5Y}\#UC$	1.042***	1.009***	0.755***	0.786***
	(0.0253)	(0.0416)	(0.0469)	(0.0501)
$D_{2Y}\#UC$	1.069***	1.021***	0.804***	0.838***
	(0.0513)	(0.0505)	(0.0778)	(0.0839)
$D_{10Y}\#SC$	0.000566	0.313***	0.982***	1.354***
	(0.0305)	(0.0687)	(0.0895)	(0.0751)
$D_{5Y}\#SC$	0.0263	0.248***	0.818***	1.367***
	(0.0171)	(0.0529)	(0.0972)	(0.101)
$D_{2Y}\#SC$	0.0309	0.0671**	0.511***	1.000***
	(0.0320)	(0.0301)	(0.150)	(0.116)
Constant	0.0186	-0.121*	-0.193**	-0.0202
	(0.0494)	(0.0637)	(0.0920)	(0.0941)
Observations	603	603	603	603
R-squared	0.916	0.876	0.795	0.877

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Model 2: Regression

policy announcements (Equation 3) is simply a result of a stronger coefficient of association between the unconventional surprise factor – which among other measures would include announcements of asset purchase programmes – and the sovereign yields. The regression analysis show that if anything, the contrary is the case (Table 4). Thus, I conclude that the inclusion of a sovereign commitment channel is a meaningful addition to the model and will be important to dissect the balance sheet effects in the next section.

Stage 2: Balance Sheet Projections

Finally, I proceed by applying the coefficients estimated on the second model in a balance sheet projection for the year 2012. I choose the year 2012 as in terms of sovereign yield spikes it can be seen as the peak of the crisis. Furthermore, this allows me to extend the discussion of the 2012 spike in the sovereign commitment factor. In principle this exercise can be done for all the years where maturity breakdowns of the debt of the representative banks are available. The formulae involved have been presented in debth in the Empirical Strategy section, thus here I only present the parameters and the output. One set parameters of interest are the regression estimates in Table 5. The remaining ones, namely RSE and PB as defined previously can be found in Table 8 and Table 9 in the appendix. Table 6 shows the projected average yield reaction across the assets on the balance sheet of the representative bank. Recall importantly that the balance sheet considered is the balance sheet restricted solely to sovereign exposure to Germany, France, Spain and Italy. We assume that *ceteris paribus*, i.e. the remainder of the balance sheet is uniform across countries. What I project is five different scenarios: The first one is a policy surprise in which each of the factors target, unconventional and sovereign commitment takes the average absolute value that the respective factor has taken since 2010. So to speak, this scenario is the average monetary surprise – even though it is artificially chosen to be a contractionary one. We see moderate difference in the projected average yield changes in response to such a policy surprise surprise. The size of the change seems to be positively correlated with the sovereign stress level of the respective sovereign as the German balance sheet reacts the least while the Italian one sees a jump almost twice as large. The second scenario is that of the factors measured for 2nd August 2012, where as previously discussed the sovereign commitment factor saw its most extreme spike. While it is a coincidence that the projected response in the average yield of the Italian representative balance sheet is almost equal to the sovereign commitment factor of that event, it is striking that the response is almost ten times larger than the German one. Why is that? It is the result of three circumstances adding up: First, there is the sovereign bias in all of the balance sheets. This is reaches unusually high levels during the Euro Crisis. Second, German bonds, which make up the majority of the German balance sheet, show almost no reaction to the sovereign commitment factor, while Italian bonds in turn are the most reactive ones in the sample. Third, the spike in the sovereign commitment factor is accompanied by a negative surprise in the unconventional factor. We have shown that this factor affect core sovereign yields more severely. This leads to the German balance sheet partly reacting in the opposite direction along this dimension, even though overall the projected effect is still positive. The remaining three scenarios are chosen to illustrate the impact of one single factor each. Evidently, the sovereign bias in the balance sheets is strong enough to transfer patterns we saw with the sovereign yields to the average yields reactions of the balance sheet of the domestic banks: The target factor has the largest impact on periphery countries, while the unconventional factor is projected to impact the average yield of core countries slightly more strongly. Obviously, the sovereign commitment factor creates the starkest contrast: the average yield in the balance sheet of the representative Italian bank is the reacts most strongly, being almost seven times larger then that of Germany, where the representative bank sees the weakest reaction in it's average yield.

	AVG	2nd August 2012	only TG	only UC	only SC
$\boldsymbol{F}=$	$\begin{pmatrix}1.698786\\2.622395\\3.374756\end{pmatrix}$	$\begin{pmatrix}4.239952\\-3.004928\\29.48867\end{pmatrix}$	$\begin{pmatrix}1.698786\\0\\0\end{pmatrix}$	$\begin{pmatrix}0\\2.622395\\0\end{pmatrix}$	$\begin{pmatrix}0\\0\\3.374756\end{pmatrix}$
DE	3.546727	3.01682	0.4807271	2.526715	0.5392847
FR	4.303632	10.39671	0.5566352	2.401272	1.345725
ES	4.803828	19.25557	0.4627427	2.006483	2.334602
IT	6.178345	29.00862	0.6510902	2.115934	3.41132

Table 6: Balance Sheet Projection: Various Scenarios

Limitations

While this project, especially in its first stage, builds on concepts that have previously emerged from the literature, it also contains a substantial amount of novel approaches. I begin by discussing limits arising from the data, as it has influenced the empirical strategy both in the first and in the second stage.

Data

The EA-MPD is by construction limited to a narrow set of asset classes. Besides the OIS rates there are changes in German, French, Spanish and Italian bond yields. While this is perfectly sufficient for the approach taken by Altavilla et al. (2019) which solely use the OIS rates, I believe that the method of factor extraction I have chosen could be improved by including additional countries. While the four countries in this sample do exhibit a varied risk profile, the Euro debt crisis saw a number of countries' yields skyrocket way above the spikes that observed with Italy and Spain. Extending the sample for which this high frequency data is available would further be crucial for testing the external validity of the newly developed model. As I have shown for the model based solely on zero-risk rates, the explanatory power dropped starkly when considering non-core countries. It would be important to extend the same step to the new model, to see whether or not the number of factors the Kleiberger-Paap test detects increases as more countries are included.

Furthermore in the second stage, my empirical strategy was limited to the number of countries from the first stage. Thus for the balance sheet calculation I had to constrain myself to a narrow subset of countries only. While I have no doubt that my projection singled out the essence of the interaction between sovereign bias and the sovereign commitment channel, the precise numbers are really only valid within this model world and under the strong assumption that yield shifts in other areas of the balance sheet are negligible when comparing representative banks of the countries.

Lastly, the EBA data that I base the measures of relative sovereign exposure as well as the projected average yield changes on is a compilation from vastly different banking supervision exercises. As stated before, this leads to the panel being unbalanced and the sample of banks included each year varies greatly. This has a limiting impact on my findings as only relative exposures, but not absolute exposures can be considered. Furthermore there is a possibility that some of the patterns are skewed due to changing composition of the banks sample. Furthermore, the fact that I had to use large bins to bundle bonds of vastly different maturities may have introduced biases into the projection of the balance sheet effects. This is why it is important to consider the respective section as a rough approximation.

Terminology

The labelling of this factor developed out of the realization that as soon as I regress yield changes in risky bonds, like the Italian ones, on the original factors from model 1 the explanatory power dropped drastically. Furthermore, its identification is based on the requirement that it only loads on sovereign spreads, which generally measure sovereign default probabilities. However, it may well be that the factor simply captures a different type of quantitative easing, which cannot be captured unless a set of assets with a broader risk profile is used for the factor extraction. Hence, I believe it is important to investigate further the mechanisms at play to ensure the terminology fits the causal channel of transmission more precisely. This could be done for example by deploying text analysis on the announcement speeches.

4 Conclusion

This paper explores market based measures of monetary policy surprises with the aim of finding an identification method that suits the heterogeneity of the Euro Area. I successfully include sovereign spreads into the model, and I show by the means of a statistical test that doing so increases the number of relevant latent factors in the data by one. The resulting factor, termed sovereign commitment, greatly improved the share of variance in risky sovereign yields that my model can account for. Clearly, a sovereign commitment factor can only play a role in a situation of crisis and I showed how it was especially dominant during the Euro Crisis of the early 2010s. Apart from identifying this new factor, I consider how it interacts with the sovereign bias of European banks. While this increased exposure makes financial systems vulnerable to the doom loop, I argue that in a situation of crisis the sovereign bias actually enables the central bank to strengthen the balance sheet of banks in crisis-stricken countries. By performing a back of the envelope calculation I show how an average policy surprise during the Euro Crisis disproportionately affected the average yield of the representative banks in countries like Spain and Italy. Of course there are two sides to this medal: While these balance sheets benefit from expansionary policy surprises, when the ECB fails to deliver on expectations, the same channel leads to a depreciation of the balance sheet.

5 Appendix

	Sum	Mean	SD	Min	Max	N
OIS_1M	27	0.14	3.00	-20	14	201
OIS_3M	19	0.09	2.96	-11	16	201
OIS_6M	23	0.12	3.35	-14	17	201
OIS_1Y	10	0.05	4.12	-18	20	201
OIS_2Y	-29	-0.15	4.54	-23	19	201
OIS_5Y	-24	-0.12	4.34	-20	15	201
OIS_10Y	-0	-0.00	3.23	-13	16	201
DE2Y	-12	-0.06	4.82	-26	23	201
DE5Y	-24	-0.12	4.35	-20	15	201
DE10Y	1	0.00	3.24	-13	16	201
IT2Y	-67	-0.34	6.28	-25	34	201
IT5Y	-49	-0.24	6.92	-22	44	201
IT10Y	-5	-0.03	6.35	-20	46	201
FR2Y	-40	-0.20	4.83	-26	21	201
FR5Y	-64	-0.32	4.57	-20	16	201
FR10Y	-17	-0.08	3.65	-15	19	201
ES2Y	-85	-0.42	4.98	-25	21	201
ES5Y	-94	-0.47	5.01	-21	20	201
ES10Y	-22	-0.11	5.01	-16	29	201

Table 7: EA-MPD: Summary Statistics

k	c	RSE_{DE}	RSE_{FR}	RSE_{ES}	RSE_{IT}
2Y	DE	.8907147	.0120732	.2132035	.1218744
5Y	DE	.8428267	.0065367	.1622371	.0685718
10Y	DE	.7210841	.0080108	.1326649	.0973106
2Y	FR	.0223776	.0294478	.515132	.0060265
5Y	FR	.049789	.0105718	.6518391	.0021912
10Y	FR	.0385023	.0057135	.5854217	.0053561
2Y	ES	.0397727	.9310383	.0589771	.0171165
5Y	ES	.0616548	.9619071	.0250038	.0237585
10Y	ES	.0376876	.9439293	.0241154	.0016819
2Y	IT	.0471349	.0274407	.2126874	.8549827
5Y	IT	.0457295	.0209844	.16092	.9054785
10Y	IT	.202726	.0423465	.257798	.8956515

Table 8: Balance Sheet Projection: RSE in 2012

	DE	FR	ES	IT
BP_{2Y}	0.4413624	0.3097862	0.4640864	0.6175653
BP_{5Y}	0.36125	0.4876805	0.424935	0.2247956
BP_{10Y}	0.1973876	0.2025332	0.1109786	0.1576391

Table 9: Balance Sheet Projection: BP

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