Macroprudential Regulation and Sector-Specific Default Risk*

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Abstract

This paper studies the transmission of macroprudential policies across both financial and non-financial sectors of the economy. It first documents that tighter macroprudential regulations implemented in Europe over the period 2008–2017 lowered default risk not only in the financial, but also in non-financial sectors. Second, the paper analyzes the impact of two reforms in the macroprudential framework. Higher capital requirements improve the long-run resilience of the financial sector but at the cost of raising long-term default risk in non-financial sectors. Strengthening the resolution framework for failing banks has beneficial long-run effects on the default risks of the financial and non-financial sectors. Our results concur with the literature documenting how banks adjust their balance sheet composition and credit supply in reaction to changes in their regulatory environment.

Keywords: Macroprudential regulation, Default risk, Capital requirements, Bank bail-in

*The authors thank the Credit Research Initiative (CRI) of the Asian Institute of Digital Finance at the National University of Singapore for the authorization of using their database and in particular, Duan Jin-Chuan, Zhang Jiayu and Thibaud Jack Limandat. We are also grateful for excellent comments Nina Biljanovska, Romain Bouis and Selim Elekdag. We thank the participants at McGill University and at Université catholique de Louvain for their questions and comments. Jean-Charles Wijnandts gratefully acknowledges research support from the Belgian Fonds National de la Recherche Scientifique (F.R.S. - FNRS) under the ASP grant (grant code: FC 7207). Bertrand Candelon has conducted this research under the research program "Financial and Extra-Financial Risks Modeling" under the aegis of the Europlace Institute of Finance, Insti7. The usual disclaimers apply: The views expressed here are those of the authors, and the paper does not represent the views of the IMF, its Executive Board or its management. This paper should not be reported as representing the views of the Bank of England or members of the Monetary Policy Committee, Financial Policy Committee or Prudential Regulation Committee.

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1. Introduction

The Global Financial Crisis (GFC) of 2008–2009 brought to light the importance of taking a macroprudential approach to financial stability. The lessons learned from this exceptional event fostered international efforts to develop a comprehensive macroprudential framework which could mitigate the risk of an amplification of shocks to the real economy by the financial system. A large literature, summarised in Forbes (2021), has focused on assessing the effectiveness of macroprudential regulation. In particular, several papers study the impact of macroprudential regulation on financial stability and the real economy and find that tighter regulation improves the resilience of the financial system to shocks, although at the cost of depressing economic activity in the short run; see e.g. Belkhir et al. (2022). However, the approach commonly adopted in these studies is to consider the aggregate effects of macroprudential regulation and little is known about the transmission of macroprudential policies to the non-financial sectors of the economy or whether some of them are more sensitive to short-term contractions in credit supply and economic activity resulting from tighter regulation.

In this paper, we provide a comprehensive analysis of the transmission of macroprudential regulation across both financial and non-financial sectors of the economy through the lens of its impact on short- and long-term probabilities of default (PDs) at the sector level. To this end, we combine a detailed database on macroprudential policies in European countries compiled by the European Central Bank (ECB) with data on short- and long-term PDs for financial and non-financial sectors (basic materials, consumer (non-)cyclical, industrial, and technology) in European countries over the period 2008–2017.

This paper has two main contributions. First, we investigate whether tighter macroprudential regulation also transmits to non-financial sectors of the economy and whether its impact is beneficial — i.e. reduces non-financial sector's risk of default — or detrimental. We construct an intensity-adjusted macroprudential policy index (MPI), which summarises the overall policy stance of each country, and study its interactions with sector-specific default risk in a dynamic panel setting which is particularly appropriate to capture the progressive transmission of macroprudential policies. For the financial sector, we document that a one unit increase in the MPI — corresponding to a new activation of a macroprudential policy instrument — significantly reduces long-term default risk at both short and long horizons — by respectively 0.425 and 4.20 basis points (bps). This impact at a long horizon corresponds to a 3.5% reduction in long-term default risk compared to its median level. For non-financial sectors, we find that a one unit change in the MPI significantly decreases both short- and long-term default risks. The reduction in long-term default risk at a long horizon ranges from 1.79 for the consumer cyclical sector to 4.7 bps for the industrial sector; corresponding to a reduction in long-term default risk ranging from 1 to 3% when compared to the respective median levels. Our analysis thus highlights that tighter macroprudential regulation also benefits non-financial sectors of the economy on average and that the economic and statistical significance of the reduction in default risk is comparable to the results for the financial sector.

Second, we analyse on a more granular level how specific reforms in the macroprudential framework dynamically impact default risk in the financial and non-financial sectors. Indeed, the analysis based on the MPI aggregates numerous macroprudential policy instruments which can differ in their aims and targets — e.g. instruments aimed at borrowers' level of indebtedness vs. those aimed at financial institutions' balance sheet resilience — and, therefore, can ultimately conceal the relevant channels of transmission involved. We study in a panel event-study framework two important macroprudential reforms taking place at the European level: i) the phasing in of the Basel III standards on capital requirements through the Capital Requirements Regulation and Directive (CRR/CRD IV) in June 2013; and ii) the introduction of a resolution framework for failing banks through the Bank Recovery and Resolution Directive (BRRD) in May 2014.

Concerning the impact of higher capital requirements, we find for the financial sector that the policy reform initially increased both short- and long-term default risks but eventually led to a significant decrease in default probabilities at a horizon of 5 quarters after its introduction and beyond; in particular, short-term default risk is 1.88 bps lower than before the reform — a 38% decrease compared to the median level. Non-financial sectors, on the other hand, appear to have suffered from a continued increase in default risk. This is especially the case for long-term default risk with increases at a horizon of 5 quarters after the policy reform ranging from 4.19 bps for the industrial sector to 12.05 bps for the basic material sector, respectively 2.5 to 7.6% higher than corresponding median levels. We also document a marked long-run increase in short-term PDs for the consumer non-cyclical and technology sectors of respectively 1.18 and 1.27 bps compared to before the reform, a 24% increase above median levels. Moving to the impact of the introduction of a European framework for bank resolution, we document that this policy reform led to a substantial decrease in both short- and long-term PDs for the financial and non-financial sectors at a horizon of 5 quarters after its introduction and beyond. Specifically, we observe decreases in short-term PDs ranging from 2.09 to 4.78 bps and from 9.3 to 20.44 bps for long-term PDs compared to before the reform — translating to a 47 (technology sector) to 76% (financial sector) decrease below median levels for short-term default risk and a corresponding 6.7 to 17.3% reduction for long-term default risk. We conclude from our analysis that the detrimental effect of the CRR/CRD IV package on the risk of default of non-financial sectors is likely a consequence of banks' reacting to increased capital requirements, expressed as a fraction of their risk-weighted assets, by shrinking their assets rather than increasing their capital levels and the resulting contraction in credit supply (Gropp et al. (2018)). This is however not the case for the impact of the BRRD as a strengthening in the resolution framework, fostering a transition away from government bailouts and towards a bail-in regime, increases risk-monitoring incentives for banks' shareholders and creditors which in turn reduces banks' risk-taking (Cutura (2021)) and increases their ability to supply credit (Altunbas et al. (2010)), thus reducing default risk in the non-financial sectors.

Our work contributes to multiple branches of the literature on macroprudential regulation. The first part of the paper complements and extends the literature documenting how macroprudential regulation contributes to improving the resilience of the financial system (Belkhir et al. (2022); Meuleman and Vander Vennet (2020)) by providing evidence of its beneficial effects on short- and long-term average default risk in non-financial sectors. In this respect, it also relates to the literature documenting how a buildup of systemic risk in the financial system can increase downside risks to the real economy (Allen et al. (2012); Giglio et al. (2016); Brownlees and Engle (2017)). Our analysis of the CRR/CRD IV package in the second part of the paper contributes to the literature studying the impact of higher capital requirements on the resilience of the financial system (Jordà et al. (2020)) and on the real economy (Gropp et al. (2018); Fraisse et al. (2020)). Our results also extend the literature studying how short-term transitional costs, due to a reduction in credit supply and aggregate demand, can partially offset longer-term benefits of increased capital requirements (Mendicino et al. (2020)). We document that the impact of reduced access to credit on default risk of non-financial sectors might have long-lasting effects. By studying the impact of the strengthening in the resolution framework associated with the introduction of BRRD, we complement the findings of Cutura (2021) about the perceived credibility of the newly introduced bail-in framework and provide evidence of the beneficial effects of transitioning away from a bailout regime where (expected) government recapitalizations increase banks' risk taking and default risk (Dam and Koetter (2012); Duchin and Sosyura (2014)) which can in turn increase default risk in non-financial sectors (Bersch et al. (2020)). Our contribution also relates to papers analysing the real effects of banks' bail-ins (Beck et al. (2020)). Finally, by analysing how macroprudential regulation impact probabilities of default of non-financial sectors of the economy, we also contribute to the literature studying the unintended consequences from macroprudential regulation on areas of the economy not directly targeted by the policies (Ahnert et al. (2021)).

The rest of the paper is structured as follows. Section 2 describes the data on sector-specific probabilities of default and macroprudential policies. Section 3 analyses the average impact of macroprudential regulation on sector-level default risk in a dynamic panel setting. Section 4 studies the implications of two important policy reforms, an increase in banks' capital requirements and a strengthening in the resolution framework for failing banks, using a panel event-study approach. Finally, Section 5 concludes.

2. Data

2.1. Sector-specific probabilities of default

Data on default probabilities are various. Still, if one wants to obtain sufficient granularity and a wide coverage for a large numbers of countries for a long sample size, the offer is rather limited. Nevertheless, the Credit Research Initiative (CRI) at the National University of Singapore tackles this limitation and provides daily updated probabilities of default (PDs) for $34,000$ actively-listed firms in 128 economies based on historical defaults and industry exits of listed firms.[1] Their methodology is based on the forward intensity model of Duan et al. (2012) which offers a parsimonious setting to predict corporate defaults at multiple horizons using both economy- and sector-wide variables; and firm-specific variables.[2] Following the extensions introduced in Duan and Fulop (2013), the current implementation of the model also accounts for correlations of individual forward intensities through common risk factors and apply Nelson-Siegel functional restrictions on model parameters across the different default horizons forecast to ensure consistency in the resulting predictions. The CRI approach thus delivers a comprehensive and accurate overview of the credit risk profile of corporate firms at both short- and long-term horizons. It is also worthwile mentioning that several recent papers have used it as Asis et al. 2020 inter alii.

We retrieve daily PDs, with default horizons of 6 months and 5 years, from the CRI database for 6 corporate sectors — namely basic materials, consumer cyclical, consumer non-cyclical, financial, industrial, and technology — and 28 European countries.[3] For each pair of country-sector, we have daily observations on the median of individual firms' PDs which we then aggregate to a monthly frequency by taking the average over the observations within a given month. Our sample covers the period from 2008 to 2017 as data availability issues for some country-industry pairs restrict our ability to work with a fully-balanced panel for each sector. Our choice of 2008 as a starting point for the analysis thus attempts to strikes a balance between maximizing the country coverage for each sector and including relevant periods — i.e. the post Global Financial Crisis period — for macroprudential policy making. Note that our decision to end the sample in 2017 is conditioned by restrictions on data availability for our dataset of macroprudential policy decisions; see Section 2.2 for more details.

Table 1 provides summary statistics, expressed in basis points (bps), for the monthly median PDs across the 6 sectors considered in our analysis. Panel A presents these statistics for the full sample of 28 European countries and Panels B, C present summary statistics for

[1]The interested reader can consult their website for more information: https://nuscri.org/en/.

[2]The economy/sector-wide variables considered are stock index return, short-term interest rate, and average distance-to-default of the financial and non-financial sector. The Firm-specific variables include volatility-adjusted leverage, liquidity, profitability, relative size, market misvaluation, and idiosyncratic volatility.

[3]The list of countries includes the 27 countries for the European Union (EU) and the United Kingdom.

the subsamples of euro area (EA) and non euro area (non-EA) countries. When considering long-term default risk, measured by the probability of default at a horizon of 5 years, we observe that the financial sector's default risk is materially lower than default risk in non-financial sectors of the economy.[4] This is however not the case when considering short-term default, measured by the probability of default at a horizon of 6 months, as the default risk of the financial sector is comparable to the ones in the consumer non-cyclical and technology sectors. A potential explanation for this difference lies in our choice of sample coverage for the analysis which includes the episodes of the GFC and the euro area sovereign debt crisis — both of which exerted considerable pressure on the resilience of the financial sector. This explanation is consistent with the higher short-term mean default risk and larger variability, measured by the standard deviation, observed in the subsample of EA countries which were directly impacted by the sovereign debt crisis.

2.2. The Macroprudential Policies Evaluation Database

We use the recent dataset on macroprudential policies in the banking sectors for 28 European countries between 1995 and 2017. The Macroprudential Policies Evaluation Database (MaPPED) developed by Budnik and Kleibl (2018) offers a detailed overview of the "life-cycle" of policy instruments including their activation dates, ensuing changes in the scope or the level of the instruments, and finally their deactivation dates when applicable. As the legal framework organizing macroprudential supervision has been developed concurrently with its implementation, as exemplified by the 2013 European regulation on the Single Supervisory Mechanism (SSM) which confers macroprudential competencies to the ECB and national authorities, Budnik and Kleibl (2018) operationalize their definition of a macroprudential instrument as a prudential tool which satisfies at least one of the following conditions: i) it has been identified as macroprudential by the competent authority or in the relevant legislation; ii) its implementation is motivated by macroprudential objectives (e.g. preserving financial stability); iii) the prudential tool is comparable in its design or work through the same transmission channels as subsequently introduced macroprudential instruments and is

[4]The difference between the 5-year PDs of the consumer non-cyclical and financial sectors ranges from 15 to 30 bps, depending on the subsample considered and whether the mean or median is used in the calculations.

Table 1: Descriptive statistics for the sector-specific median probabilities of default.

Sector	Horizon	Mean	Min	1^{st} quartile	Median	3^{rd} quartile	Max	Std Dev
Panel A: All countries								
Fin	6-M	9.61	0.03	1.95	4.96	10.38	623.83	21.56
	5-Y	124.57	15.93	74.16	118.32	155.96	1408.63	75.63
Cons cyc	6-M	13.66	0.03	3.10	7.12	17.34	171.53	17.76
	5-Y	173.02	13.86	116.58	159.05	217.85	687.75	83.47
Cons non-cyc	6-M	9.02	0.18	2.29	4.87	11.45	181.68	11.95
	5-Y	149.25	32.88	104.75	134.38	183.52	610.32	61.63
Indus	6-M	14.35	0.00	3.86	8.20	17.80	231.58	19.44
	5-Y	184.36	1.80	128.94	169.30	229.16	837.25	86.82
Bas mat	6-M	11.69	0.02	3.45	6.92	12.97	441.64	19.58
	5-Y	172.22	24.12	119.74	163.15	206.53	1726.56	89.59
Techno	6-M	8.51	0.00	2.59	5.27	11.18	71.40	9.10
	5-Y	151.06	11.44	113.45	145.60	187.62	541.57	60.20
Panel B: EA countries								
Fin	6-M	9.98	0.03	1.49	4.16	10.37	623.83	25.36
	5-Y	118.85	15.93	63.88	105.72	152.11	1408.63	84.36
Cons cyc	6-M	13.07	0.03	2.14	5.41	16.56	171.53	18.73
	5-Y	158.26	13.86	98.22	142.15	195.59	687.75	86.89
Cons non-cyc	6-M	8.71	0.18	2.08	4.17	9.70	181.68	13.38
	5-Y	139.75	32.88	100.57	123.06	162.96	610.32	59.32
Indus	6-M	14.20	0.00	3.16	7.00	17.19	231.58	21.35
	5-Y	175.78	1.80	118.80	153.68	220.54	837.25	94.90
Bas mat	6-M	9.05	0.20	2.82	5.02	10.72	194.33	12.15
	5-Y	153.02	39.29	107.37	143.94	187.00	828.68	66.73
Techno	6-M	8.43	0.00	2.21	4.79	11.31	53.21	9.22
	5-Y	142.13	11.44	106.43	135.64	174.43	347.13	52.92
Panel B: Non-EA countries								
Fin	6-M	8.92	0.44	3.21	5.76	10.40	140.53	11.30
	5-Y	135.37	49.43	100.91	128.83	161.08	556.70	53.93
Cons cyc	6-M	14.65	0.34	4.93	9.74	17.92	155.16	15.97
	5-Y	197.62	45.89	143.67	187.75	235.66	526.55	70.95
Cons non-cyc	6-M	9.53	0.43	3.06	6.53	13.29	62.08	9.05
	5-Y	165.08	51.56	117.44	158.93	201.79	486.13	62.19
Indus	6-M	14.72	0.67	5.67	10.17	19.89	113.75	13.77
	5-Y	205.20	68.06	160.84	200.99	242.19	436.62	58.01
Bas mat	6-M	16.21	0.02	6.19	9.85	15.80	441.64	27.48
	5-Y	205.13	24.12	159.90	192.36	227.72	1726.56	111.56
Techno	6-M	8.69	0.15	3.45	6.21	11.13	71.40	8.86
	5-Y	168.93	21.25	138.02	162.01	207.44	541.57	69.26

Note: The table presents summary statistics for the sector-specific median probabilities of default (in bps) at horizons of 6 months and 5 years over the period 2008-2017. Panel A considers all the countries in our sample and Panels B and C consider respectively the subsamples of EA and Non-EA countries.

likely to broadly impact the banking-sector.[5] Based on this definition, the authors created a closed list of 53 macroprudential policy instruments classified in 11 categories.[6]

The literature studying the impact and transmission of macroprudential regulation has adopted different approaches to track the evolution of the macropudential policy stance. A first approach focuses on the (de-)activation of policy tools by creating a policy index summarising with dummy variables whether each of the policy instruments in a given reference category is active at a given point in time (Lim et al. (2011), Claessens et al. (2013)). A second approach also considers the recalibrations and changes in scope of the policy instruments occurring over their life-cycle — i.e. between their activation and potential phasing-out — together with an asymmetric treatment of policy decisions resulting in a tightening vs. easing of the regulatory stance; e.g. by assigning a positive sign to the dummy variables associated with tightening events and a negative sign to the ones associated with loosening events. This approach enables an investigation of the impact of macroprudential tightenings/easings (Kuttner and Shim (2016), Bruno et al. (2017)) and, at the same time, to create a Macroprudential Policy Index (MPI) summarizing the overall macroprudential policy stance at one point in time — or for a subset of policy instruments — by taking the difference between the cumulative index of tightenings and easings; see e.g. Cerutti et al. (2017), Akinci and Olmstead-Rumsey (2018). A potential limitation of this last approach is that it only captures the direction of the variations in the macroprudential policy stance but provide limited information about the intensity of these variations. Further to this point, the equal treatment given to (de-)activations of policy instruments compared to changes in either the level or scope of these instruments can lead to a situation where large variations in the MPI do not reflect large variations in the underlying instruments and the policy stance. An example of the later is the case of an instrument which would be frequently recalibrated/reevaluated but only with small incremental variations.[7]

[5]Relevant examples include the similarities between minimum capital requirements and macroprudential capital buffers (Aiyar et al. (2014)), and between dynamic provisioning and the countercyclical capital buffer (Jiménez et al. (2017))

[6]The 11 categories are: minimum capital requirements, capital buffers, risk weights, leverage ratios, loan-loss provisioning, lending standards restrictions, limits on credit growth and volumes, limits on large exposures and concentration, liquidity requirement and limits to currency mismatches, and other measures which contains mainly crisis-related measures and resolution tools.

[7]Policy tools with a time-varying component, such as the countercyclical capital buffer or supervisory

To address this limitation and use all the richness of the information contained in the MaPPED, we construct an intensity-adjusted macroprudential policy index which assigns different weights to the respective phases of the life-cycle of a given policy instrument; see e.g. Vandenbussche et al. (2015), Richter et al. (2019), and Meuleman and Vander Vennet (2020) for other examples of empirical analyses using an intensity-adjusted MPI. First, events associated with the introduction or phasing out of the policy instrument (first activation or deactivation) receive the highest weight of 1.00. Second, events affecting the level of the policy instrument receive a higher weight than events affecting the definition/scope of the instrument (respectively 0.25 and 0.10). Finally, events resulting in maintaining the level and scope of a tool receive a weight of 0.05. To complete the description of the intensity-adjusted MPI, we multiply weights associated with events reported as a policy tightening/loosening by +1/-1 to reflect their contribution to the overall macroprudential policy stance. Events whose impact on the policy stance are reported as ambiguous are not taken into account in our analysis.

Table 2 provides summary statistics for the intensity-adjusted MPI over the period ranging from 2008 to 2017 — our reference period in the empirical analysis. Panel A presents these statistics for the full sample of 28 European countries and Panels B, C present summary statistics for the subsamples of euro area (EA) and non euro area (non-EA) countries. The use of macroprudential policies appears to be more prevalent in non-EA countries (mean MPI: 18.13) than in EA ones (mean MPI: 15.49). In addition, the MPI has higher variability in the subsample of non-EA countries — with a standard deviation of 7.92 compared to 5.98 for EA countries — which potentially reflects the higher heterogeneity in the composition of the subsample. Given the relatively larger share of EA countries in our sample (18 vs. 10 non-EA countries), the results for the panel including all the countries might overweight the role of EA countries. Therefore, we will also carry out our analysis on the two subsamples of countries to identify potential differences in the impact and transmission of macroprudential regulation.

capital add-ons, are good examples of instruments whose level is reassessed periodically.

3. Macroprudential regulation and default risk in a dynamic panel setting

This section sets out our empirical approach to analyze the impact of macroprudential policies on both short (6-month) and long-horizon (5-year) default probabilities of financial and non-financial sectors of the economy. We opt for a dynamic panel setting which has been favoured in the literature assessing the transmission of macroprudential policy decisions; see e.g. Kuttner and Shim (2016), Cerutti et al. (2017), Akinci and Olmstead-Rumsey (2018) and Meuleman and Vander Vennet (2020). Section 3.1 details the model specification and Section 3.2 summarises the results.

3.1. Model specification and relevant predictors of corporate defaults

We propose to analyze the transmission of macroprudential policy decisions to default risk at the sector level by estimating the following dynamic panel regression model for each sector:

$$PD^{(h)}_{c,t} = \eta_c + \sum_{l=1}^{L} \rho_l PD^{(h)}_{c,t-l} + \delta MPI_{c,t-1} + \sum_{k=1}^{K} \beta_k X_{k,c,t-1} + \varepsilon_{c,t}, \tag{1}$$

where $PD^{(h)}_{c,t}$ is the sector-specific default probability at a horizon $h \in \{\text{6M; 5Y}\}$ in country c at time t and η_c is a country-specific fixed effect capturing cross-country differences in the average default probability.[8] First, we include lags of the dependent variable, PD, to control for any unmodeled sources of persistence in default probabilities and mitigate any potential concerns of serial correlation in the error term, $\varepsilon_{c,t}$.[9] Second, we include the lagged macroprudential policy index (MPI) introduced in Section 2.2. We follow the existing literature (Cerutti et al. (2017), Akinci and Olmstead-Rumsey (2018), Meuleman and Vander Vennet (2020)) and consider a cumulative measure of the macroprudential policy stance to capture the fact that announced policy changes can affect our variable of interest both at the time of announcement and in subsequent months. Potential reasons for this delayed or progressive transmission of announced changes in the macroprudential policy stance are i) the implementation lag usually separating the announcement of a new policy action from its actual

[8] As the estimation is carried out for each sector separately, η_c is *de facto* a country- and sector-specific fixed effect.

[9] We opted for a specification with 3 lags of the dependent variable. Our main results remain robust to alternative lag length choices.

enforcement date; and ii) the use of transitional regimes by supervisory authorities.[10] Our dynamic panel setting is particularly appropriate to capture this aspect of macroprudential policy decisions as we capture both the announcement impact, via the parameter δ, and the long-run effect of a one unit change in the macroprudential policy stance which is given by $\delta/(1-\sum_{l=1}^{L}\rho_l)$. The dynamic specification also allows us to interpret the significance of the parameter estimates as indicative evidence for the presence of (Granger-) causality.

Third, we control for variations in default risk related to the evolution of the macro-financial environment by borrowing relevant explanatory variables from the literature on predictors of corporate default risk.[11] Macroeconomic conditions are a strong determinant of corporate default risks due to, e.g., their pro-cyclical impact on both corporate earnings (Longstaff and Piazzesi (2004)) and debt and equity issuance (Covas and Den Haan (2011)); and the emergence of flight-to-liquidity episodes in corporate bond markets during stressed economic conditions (Acharya et al. (2013)). Therefore, we include the year-on-year percentage change in country-specific industrial production excluding construction (IP) to reflect that a contraction in economic activity tends to be associated with heightened corporate default risk (Lando and Nielsen (2010), Giesecke et al. (2011)). We also include the year-on-year percentage change in the country-specific harmonised index of consumer prices (HICP) as our measure of inflation (Inf) to capture the contribution of low (expected) inflation to corporate default risk through a corresponding increase in real debt liabilities (Bhamra et al. (2011), Fiore et al. (2011), Gomes et al. (2016)). In addition, we incorporate the trailing one-year inflation volatility (InfVol) as Kang and Pflueger (2015) showed that it contributes significantly to explaining credit spread variations for a panel of G7 countries over the period 1970–2010. We also consider a set of financial predictors, starting with the stock market

[10]To illustrate the first point, increases in the level of financial institutions' countercyclical capital buffer (CCyB) announced by the relevant supervisory authority should lead the effective date of implementation by up to 12 months (see Section 6 of BCBS (2015)). A relevant example on the second point is the transitional provision on the implementation of the capital conservation buffer (CCoB) provided in the Capital Requirements Directive (See CRD IV: 2013/36/EU Article 160) which permits a gradual phasing-in of the CCoB from 0.625% of risk-weighted assets (RWA) in 2016 to 2.5% of RWA in 2019.

[11]Note that we do not consider time fixed effects in our analysis as the lagged PDs and the lagged macro-financial explanatory variables are already capturing relevant time variations in sector-specific default risk. This approach is consistent with the existing literature; see e.g. Kuttner and Shim (2016), Cerutti et al. (2017), Akinci and Olmstead-Rumsey (2018).

return (StockRet) which we compute as the one-year trailing return for each country's major stock market index and the corresponding stock market volatility (StockVol). Giesecke et al. (2011) document that stock market downturns and increased stock market volatility correlates with higher corporate default probabilities. Finally, we include proxies for changes in short-term interest rates (Δ ShortRate) and for the slope of the government bond yield curve given their documented ability to forecast future real economic activity and variations in corporate default risk; see e.g. Estrella and Hardouvelis (1991) and Hamilton and Kim (2002) for an empirical analysis of predictive ability and Duffie et al. (2009) and Lando and Nielsen (2010) for an application to default risk modelling.[12] Note that we refrain from including firm or industry-specific risk factors such as measures of distance-to-default (Duffie et al. (2007), Lando and Nielsen (2010)) and accounting ratios as Azizpour et al. (2018) show that macroeconomic predictors of corporate default risk account for the majority of cross-sectional variations in firm-specific default risk factors.[13] Table 2 below provides descriptive statistics for our set of explanatory variables.

Before moving to the analysis of the results, we consider potential challenges associated with the study of the transmission of macroprudential policies to sector-specific default risk within a reduced-form dynamic panel with country fixed effects as specified in Equation (1). Concerns about potential endogeneity issues with the macroprudential policy index could arise if the macroprudential policy authorities introduced new measures in reaction to changes in the macro-financial environment which also affect the probability of default in some sectors of the economy. This might induce a bias in the estimate of the coefficient measuring the impact of macroprudential policy decisions on default risk. However, we posit that endogeneity and reverse causality issues should not materially impact the interpretation of our results for two reasons. First, we carry out our analysis at the monthly frequency by aggregating daily data on probabilities of default at the sector level for each month in our sample. On the other hand, macroprudential monitoring is conducted at a lower frequency,

[12]Depending on data availability, we use a 3-month benchmark government bond yield or the interbank rate to proxy for short-term interest rate and the difference between the 10-year benchmark government bond yield and the corresponding 1- or 2-year yield to proxy for the slope of the yield curve.

[13]We have also considered in preliminary analysis variables capturing factors common across countries and sectors such as the Economic Policy Uncertainty (EPU) index of Baker et al. (2016). We decided not to include it in the final analysis as it was not a significant driver of PDs' variations.

Table 2: Descriptive statistics for explanatory variables

	Mean	Min	1^{st} quartile	Median	3^{rd} quartile	Max	Std Dev
			Panel A: All countries				
MPI	16.34	1.50	10.80	15.50	21.40	34.35	6.78
Inf	1.84	-4.30	0.40	1.5	2.90	17.70	2.23
IP	0.71	-31.70	-2.70	1.30	4.90	56.70	8.18
InfVol	0.74	0.08	0.36	0.57	0.91	4.49	0.58
StockRet	-3.32	-165.01	-15.95	3.49	15.54	96.33	30.48
StockRetVol	20.97	5.56	14.02	19.06	25.10	64.27	9.85
Δ ShortRate	-0.04	-8.20	-0.06	-0.01	0.02	4.14	0.36
Slope	1.86	-8.50	1.14	1.68	2.55	11.96	1.41
			Panel B: EA countries				
MPI	15.49	4.1	10.95	15.20	18.60	31.75	5.98
Inf	1.70	-4.30	0.30	1.40	2.80	17.70	2.18
IP	0.56	-31.70	-3.00	1.00	4.80	56.70	8.79
InfVol	0.74	0.08	0.37	0.56	0.91	4.49	0.60
StockRet	-4.48	-164.43	-17.68	3.45	15.40	75.97	30.82
StockRetVol	21.61	5.56	14.50	19.88	26.20	64.27	10.04
Δ ShortRate	-0.04	-8.20	-0.07	-0.01	0.02	4.14	0.40
Slope	2.02	-8.50	1.19	1.82	2.67	11.96	1.57
			Panel C: Non-EA countries				
MPI	18.13	1.50	10.55	19.20	23.80	34.35	7.92
Inf	2.13	-2.50	0.50	1.80	3.40	14.70	2.32
IP	1.04	-26.00	-1.90	1.85	5.10	17.20	6.71
InfVol	0.73	0.11	0.35	0.59	0.92	4.16	0.55
StockRet	-0.89	-165.01	-12.28	3.54	16.10	96.33	29.61
StockRetVol	19.63	6.85	13.37	16.82	22.73	51.67	9.28
Δ ShortRate	-0.04	-2.74	-0.06	-0.01	0.02	3.01	0.23
Slope	1.55	-2.27	1.02	1.44	2.23	3.51	0.91

Note: The table presents summary statistics for the explanatory variables over the period 2008-2017. Panel A considers all the countries in our sample and Panels B and C consider respectively the subsamples of EA and Non-EA countries.

usually quarterly, using a myriad of macro-financial variables which, in addition to being sampled at low frequency in the majority of cases, are often subject to publication delays and data cutoff dates applied prior to policy meetings.[14] This potential delay between changes in the macro-financial risk environment and the associated policy reaction, created by a lack of timeliness in data availability, is further complicated by the fact that the processes associated with the design and implementation of macroprudential policy measures are inherently time-intensive. Therefore, it appears unlikely that macroprudential authorities would be able to adjust, within the same month, the stance of their policy in reaction to shocks in the risk environment also driving the variations in sector-specific probabilities of default. The fact that the macroprudential policy index and the control variables enter Equation (1) with a lag further mitigates such concerns. Second, by including explanatory variables capturing variations in default risk related to the evolution of macro-financial conditions, we also explicitly control for some of the changes in the risk environment that could endogenously drive variations in the macroprudential policy stance. Finally, we note that the Nickell (1981) bias potentially affecting the estimates of the fixed-effect parameters in small samples when lags of the dependent variable are used as regressors is not a source of concerns in our analysis given that the bias vanishes in samples with longer time series dimension and we carry out our analysis on a sample with 10 years of monthly data.

3.2. Empirical results

We can now estimate the model specified in Equation (1) to assess the average impact of macroprudential policies on both short- and long-term default risks of the studied sectors. Table 3 reports the estimates obtained for each of the sectors in Panels A to F. Each panel is further divided in three parts to contrast the results obtained for the full set of countries ("All") with the results for two subsamples of countries — euro are countries ("EA") and other non-EA countries ("Non-EA").

The introduction of tighter macroprudential regulation, captured by our MPI variable, significantly decreases the 5-year default probability (DP) of the financial sector. A unit

[14] Relevant examples include measures of indebtedness levels and debt servicing costs for the assessment of corporates and households vulnerabilities and capital levels for the resilience assessment of the financial system.

increase in the MPI, corresponding to the first-time activation of a policy instrument, decreases the 5-year DP by 0.425 bps in the short-run and 4.20 bps in the long-run. This result is robust across the two subsamples of EA and Non-EA countries and consistent with Meuleman and Vander Vennet (2020)'s result, using bank level data, that macroprudential policy actions decrease bank systemic risk on average.[15] The lack of statistical evidence supporting an impact of macroprudential regulation on the 6-month DP suggests that macroprudential policies tend to improve financial stability by addressing longer-term aspects of default risk.

Unexpectedly, we also find strong statistical evidence that tighter macroprudential regulation contributes to reducing default risks in non-financial sectors of the economy. The impact of a unit change in the MPI on the 5-year DP ranges from -0.24 bps (consumer cyclical sector) to -0.39 bps (industrial sector) in the short-run and, respectively, from -1.79 bps to -4.7 bps in the long-run.[16] We also obtain a statistically significant impact of tighter macroprudential regulation for the 6-month DPs with coefficient estimates whose magnitude is commensurate with the estimates for the financial sector. A subsample analysis of the robustness of these results indicates that they are mainly driven by the euro area countries. These results highlights that macroprudential regulation impacts also non-financial sectors mainly indirectly via the credit capacity of the financial sectors.

Looking at the estimation results in Table 3 for the control variables, we see that controlling for the persistence in default probabilities is important in our specification to avoid serial correlation in the residuals as the first two PD lags are significant in almost all cases and a third lag is necessary for the financial and basic materials sectors. Increased economic activity, measured by IP, significantly decreases short- and long-term default risk in the financial and consumer cyclical sectors (Lando and Nielsen (2010), Giesecke et al. (2011)).[17] The

[15] As mentioned in Section 3.1, the estimated long-run effect (Est LR effect) of a one unit change in the macroprudential policy stance is obtained by plugging the coefficient estimates of Equation (1) in $\delta/(1 - \sum_{l=1}^{3} \rho_l)$. The results are reported at the bottom of each panel in Table 3.

[16] We note that the results for the basic materials sector point to an even stronger impact of macroprudential regulation on default risk at the 5-year horizon. However, our subsample analysis reveals that the coefficient estimate is driven upward by non-EA countries whose coefficient estimate is not statistically significant.

[17] Interestingly, we do not find a significant impact of higher yearly growth in industrial production on default risk in the industrial sector — although the coefficient estimates have the expected negative sign. This can be partly explained by the fact that relevant information about the sector performance is already embedded in the dynamics of the lagged DPs and by observing that the yield curve slope, a well-documented predictor of economic activity, is significant for non-EA countries.

coefficient estimates for the slope of the yield curve are also significant and with a negative sign, consistent with the literature documenting the predictive power of a steepening in the yield curve on future real economic activity (Estrella and Hardouvelis (1991), Estrella and Mishkin (1998), Hamilton and Kim (2002)). The results for short-term default risk confirm the negative relationship between stock market performance and default risk documented in Giesecke et al. (2011). However, the results for long-term default risk are consistent with the literature documenting a positive relationship between default risk and stock returns (Duffie et al. (2007), Chava and Purnanandam (2010), Friewald et al. (2014)).

Table 3: Macroprudential Policies and sector-specific median default risk

	Panel A: Financial						Panel B: Consumer cyclical					
	All		EA		Non-EA		All		EA		Non-EA	
	6-M	5-Y	6-M	5-Y	6-M	5-Y	6-M	5-Y	6-M	5-Y	6-M	5-Y
PD L1	1.31***	1.28***	1.31***	1.28***	1.18***	1.20***	1.04***	1.02***	1.11***	1.06***	0.944***	0.964***
	(0.146)	(0.108)	(0.165)	(0.128)	(0.104)	(0.054)	(0.071)	(0.046)	(0.080)	(0.062)	(0.120)	(0.064)
PD L2	-0.819***	-0.644***	-0.839***	-0.677***	-0.477***	-0.448***	-0.171**	-0.140**	-0.240***	-0.170**	-0.087	-0.102
	(0.210)	(0.203)	(0.236)	(0.231)	(0.117)	(0.085)	(0.075)	(0.058)	(0.089)	(0.084)	(0.118)	(0.076)
PD L3	0.356***	0.263**	0.371***	0.284**	0.098	0.124**	-0.011	0.015	-0.013	0.004	0.028	0.034
	(0.112)	(0.111)	(0.123)	(0.121)	(0.061)	(0.054)	(0.043)	(0.036)	(0.054)	(0.049)	(0.067)	(0.054)
MPI	-0.072	-0.425**	-0.112	-0.535*	-0.056	-0.429**	-0.101***	-0.242*	-0.114**	-0.330*	-0.075	-0.127
	(0.068)	(0.177)	(0.125)	(0.286)	(0.040)	(0.169)	(0.035)	(0.145)	(0.052)	(0.196)	(0.059)	(0.225)
Inf	0.609**	1.68***	0.973**	2.71***	0.234***	0.692**	0.395***	1.20***	0.354***	1.23***	0.504***	1.19**
	(0.247)	(0.505)	(0.455)	(0.887)	(0.075)	(0.299)	(0.099)	(0.315)	(0.129)	(0.464)	(0.161)	(0.486)
IP	-0.035**	-0.202***	-0.037*	-0.216***	-0.050*	-0.188*	-0.018	-0.104*	-0.023*	-0.071	-0.008	-0.215
	(0.017)	(0.054)	(0.021)	(0.064)	(0.030)	(0.112)	(0.014)	(0.060)	(0.013)	(0.061)	(0.042)	(0.169)
InfVol	-0.903**	-2.29**	-0.941	-1.74	-0.878**	-3.26**	-0.338	-0.014	-0.142	0.738	-1.06*	-1.51
	(0.425)	(1.08)	(0.679)	(1.53)	(0.401)	(1.43)	(0.347)	(1.14)	(0.447)	(1.55)	(0.603)	(1.66)
StockRet	-0.021*	0.009	-0.010	0.036*	-0.026***	-0.004	-0.013**	0.033*	-0.009	0.018	-0.018	0.065**
	(0.012)	(0.017)	(0.012)	(0.022)	(0.010)	(0.025)	(0.006)	(0.018)	(0.007)	(0.023)	(0.016)	(0.033)
StockRetVol	0.004	0.056	0.054	0.186	0.005	0.055	-0.025	0.043	-0.021	0.021	-0.044	0.084
	(0.031)	(0.075)	(0.061)	(0.127)	(0.024)	(0.093)	(0.018)	(0.068)	(0.021)	(0.085)	(0.031)	(0.112)
Δ ShortRate	-0.0006	-0.167	0.136	0.325	-1.56	-6.01	-0.132	-0.948	-0.181	-1.05	0.015	-0.519
	(0.431)	(1.44)	(0.491)	(1.64)	(1.22)	(3.96)	(0.302)	(0.970)	(0.300)	(0.952)	(1.32)	(3.98)
Slope	-0.662**	-1.29*	-0.763*	-1.52*	-0.423**	-0.650	-0.262	-0.678	-0.211	-0.616	-0.662**	-1.11
	(0.325)	(0.736)	(0.422)	(0.911)	(0.215)	(0.854)	(0.174)	(0.566)	(0.205)	(0.666)	(0.328)	(1.07)
Est LR effect	-0.471	-4.20	-0.709	-4.73	-0.281	-3.46	-0.711	-1.79	-0.797	-3.11	-0.652	-1.22
Adj. R^2	0.837	0.920	0.835	0.921	0.875	0.918	0.904	0.939	0.921	0.948	0.867	0.906
With Adj. R^2	0.822	0.885	0.820	0.886	0.866	0.889	0.852	0.857	0.855	0.868	0.851	0.839
Obs	3,120		2,040		1,080		2,880		1,800		1,080	
Countries	26		17		9		24		15		9	

Table 3 (Continued)

	Panel C: Consumer non-cyclical						Panel D: Industrial					
	All		EA		Non-EA		All		EA		Non-EA	
	6-M	5-Y	6-M	5-Y	6-M	5-Y	6-M	5-Y	6-M	5-Y	6-M	5-Y
PD L1	1.18***	1.14***	1.18***	1.13***	1.14***	1.14***	1.06***	1.07***	1.03***	1.06***	1.20***	1.11***
	(0.073)	(0.044)	(0.095)	(0.063)	(0.075)	(0.060)	(0.102)	(0.037)	(0.111)	(0.043)	(0.071)	(0.060)
PD L2	-0.343***	-0.255***	-0.357***	-0.268***	-0.273***	-0.228***	-0.247**	-0.194***	-0.223**	-0.183***	-0.433***	-0.246***
	(0.099)	(0.056)	(0.120)	(0.080)	(0.064)	(0.070)	(0.097)	(0.051)	(0.104)	(0.059)	(0.097)	(0.071)
PD L3	0.046	0.041	0.045	0.038	0.057	0.034	0.079	0.042	0.091	0.045	0.066	0.042
	(0.080)	(0.042)	(0.098)	(0.060)	(0.052)	(0.056)	(0.053)	(0.043)	(0.063)	(0.051)	(0.057)	(0.045)
MPI	-0.030	-0.081	-0.095**	-0.376**	-0.005	-0.034	-0.134***	-0.385***	-0.179**	-0.492**	-0.082**	-0.247*
	(0.026)	(0.110)	(0.048)	(0.173)	(0.019)	(0.133)	(0.048)	(0.140)	(0.076)	(0.221)	(0.034)	(0.145)
Inf	0.289***	0.680***	0.408***	1.17***	0.159***	0.149	0.468***	1.09***	0.538***	1.35***	0.445***	0.813**
	(0.080)	(0.250)	(0.144)	(0.372)	(0.061)	(0.297)	(0.104)	(0.276)	(0.146)	(0.389)	(0.102)	(0.315)
IP	0.004	0.022	-0.0001	0.016	0.022	0.069	-0.012	-0.075	-0.021	-0.080	-0.036	-0.077
	(0.011)	(0.049)	(0.013)	(0.051)	(0.019)	(0.131)	(0.018)	(0.060)	(0.020)	(0.068)	(0.022)	(0.105)
InfVol	-0.325*	-0.671	-0.372	-0.868	-0.300	0.342	-1.09**	-2.45**	-1.23**	-2.38	-1.02**	-3.26**
	(0.193)	(0.865)	(0.296)	(1.05)	(0.269)	(1.43)	(0.474)	(1.21)	(0.614)	(1.57)	(0.478)	(1.50)
StockRet	-0.004	0.029*	-0.001	0.035*	-0.0005	0.030	-0.011	0.032*	-0.003	0.037	-0.022*	0.056
	(0.005)	(0.015)	(0.006)	(0.019)	(0.006)	(0.027)	(0.008)	(0.019)	(0.009)	(0.023)	(0.012)	(0.038)
StockRetVol	-0.002	0.049	0.014	0.127	-0.015	-0.027	-0.023	0.034	-0.010	0.074	-0.046	-0.018
	(0.013)	(0.058)	(0.021)	(0.081)	(0.016)	(0.104)	(0.022)	(0.069)	(0.029)	(0.093)	(0.029)	(0.109)
Δ ShortRate	-0.282	-0.821	-0.165	-0.265	-1.32**	-6.14**	-0.459	-1.66	-0.337	-1.21	-1.90	-8.67**
	(0.231)	(0.903)	(0.263)	(0.972)	(0.534)	(2.56)	(0.347)	(1.03)	(0.349)	(1.08)	(1.40)	(4.32)
Slope	-0.219*	-0.549	-0.225	-0.710	-0.344**	-0.298	-0.280	-0.786	-0.222	-0.672	-0.578**	-1.61*
	(0.122)	(0.471)	(0.145)	(0.541)	(0.144)	(0.728)	(0.207)	(0.587)	(0.243)	(0.680)	(0.290)	(0.969)
Est. LR effect	-0.256	-1.09	-0.72	-3.76	-0.066	-0.63	-1.24	-4.7	-1.75	-6.31	-0.491	-2.63
Adj. R^2	0.903	0.927	0.903	0.929	0.906	0.919	0.903	0.947	0.901	0.948	0.921	0.932
With Adj. R^2	0.873	0.888	0.874	0.883	0.876	0.897	0.861	0.881	0.857	0.882	0.894	0.874
Obs	2,880		1,800		1,080		2,880		2,040		840	
Countries	24		15		9		24		17		7	

Table 3 (Continued)

	Panel E: Basic materials						Panel F: Technology					
	All		EA		Non-EA		All		EA		Non-EA	
	6-M	5-Y	6-M	5-Y	6-M	5-Y	6-M	5-Y	6-M	5-Y	6-M	5-Y
PD L1	1.21***	1.19***	1.05***	1.11***	1.24***	1.20***	1.07***	1.05***	1.06***	1.00***	1.03***	1.06***
	(0.118)	(0.136)	(0.098)	(0.067)	(0.141)	(0.183)	(0.044)	(0.042)	(0.053)	(0.042)	(0.063)	(0.074)
PD L2	-0.725***	-0.553**	-0.397***	-0.321***	-0.796***	-0.612**	-0.242***	-0.172***	-0.262***	-0.123**	-0.177*	-0.216**
	(0.214)	(0.230)	(0.117)	(0.115)	(0.240)	(0.287)	(0.066)	(0.050)	(0.081)	(0.054)	(0.099)	(0.087)
PD L3	0.351***	0.240*	0.206**	0.102	0.388***	0.274*	0.030	0.034	0.098	0.026	-0.099	0.003
	(0.122)	(0.123)	(0.083)	(0.076)	(0.143)	(0.156)	(0.052)	(0.027)	(0.061)	(0.035)	(0.074)	(0.048)
MPI	-0.123*	-0.720*	-0.116**	-0.388*	-0.102	-0.723	-0.100***	-0.322**	-0.132***	-0.678***	-0.104***	-0.192
	(0.064)	(0.368)	(0.054)	(0.215)	(0.107)	(0.611)	(0.027)	(0.152)	(0.039)	(0.236)	(0.037)	(0.214)
Inf	0.481***	0.772*	0.500***	2.03***	0.610**	0.552	0.196***	0.572*	0.259***	1.03***	0.146	0.266
	(0.184)	(0.433)	(0.142)	(0.540)	(0.290)	(0.698)	(0.054)	(0.307)	(0.080)	(0.386)	(0.092)	(0.606)
IP	0.0002	-0.025	0.020	0.065	-0.042	-0.215	-0.005	-0.011	-0.0007	-0.007	-0.026	0.024
	(0.025)	(0.110)	(0.021)	(0.082)	(0.071)	(0.320)	(0.009)	(0.054)	(0.009)	(0.056)	(0.025)	(0.132)
InfVol	-1.16**	-3.75**	-0.954	-2.18	-1.67**	-4.32**	-0.251	0.659	-0.506*	0.218	-0.212	-0.684
	(0.530)	(1.63)	(0.686)	(2.23)	(0.775)	(2.11)	(0.214)	(1.17)	(0.292)	(1.55)	(0.352)	(1.96)
StockRet	-0.026**	-0.003	-0.020	0.028	-0.011	0.066	-0.015**	0.024	-0.002	0.057**	-0.031***	-0.0001
	(0.012)	(0.034)	(0.012)	(0.034)	(0.018)	(0.058)	(0.006)	(0.019)	(0.007)	(0.025)	(0.011)	(0.033)
StockRetVol	-0.048	-0.090	-0.028	0.185	-0.087	-0.301	-0.052***	-0.080	-0.030	0.051	-0.074***	-0.205*
	(0.030)	(0.138)	(0.030)	(0.127)	(0.063)	(0.315)	(0.014)	(0.067)	(0.019)	(0.091)	(0.022)	(0.108)
Δ ShortRate	-0.022	-0.471	0.344	0.845	-4.17	-17.2	0.091	0.445	0.295	1.36	-1.53*	-7.84**
	(0.649)	(2.24)	(0.575)	(2.01)	(3.21)	(12.6)	(0.422)	(1.55)	(0.421)	(1.49)	(0.894)	(3.17)
Slope	-0.566***	-1.52**	-0.320	-0.854	-1.64***	-4.38***	-0.208**	-0.179	-0.276***	-0.614	0.018	1.36
	(0.203)	(0.663)	(0.196)	(0.629)	(0.493)	(1.68)	(0.085)	(0.384)	(0.093)	(0.401)	(0.233)	(1.24)
Est. LR effect	-0.75	-5.85	-0.823	-3.56	-0.607	-5.24	-0.704	-3.66	-1.27	-6.99	-0.423	-1.25
Adj. R^2	0.785	0.843	0.833	0.908	0.764	0.784	0.882	0.921	0.897	0.913	0.859	0.927
With Adj. R^2	0.766	0.800	0.809	0.858	0.757	0.778	0.844	0.858	0.867	0.888	0.804	0.789
Obs	2,280		1,440		840		2,160		1,440		720	
Countries	19		12		7		18		12		6	

Note: Estimation is carried out by OLS with one-way country fixed effect dummies. The estimation period is 2008-2017. The dependent variable is the median probability of default for the sector. All regressors are considered as lagged values. We report estimates with Driscoll Kraay standard errors between brackets which are robust to general forms of cross-sectional and temporal dependence (clustered at the country level). ***, **, and * indicate significance at the 1-, 5-, and 10-percent significance levels, respectively.

The estimates for the consumer non-cyclical, industrial, and technology sectors in the non-EA subsample confirm the results in Duffie et al. (2007) on the negative relationship between changes in short-term risk-free interest rates and default risk; consistent with Jiménez et al. (2014) who document how less well-capitalized banks react to a loosening in monetary policy by increasing their credit supply to riskier firms with higher default likelihood ex-post and with Heider et al. (2019) who show that high-deposit European banks increased their risk taking after the introduction of negative policy rates. Inflation also contributes significantly to explaining variations in default risks across all sectors and horizons. While the positive sign of the coefficient estimates appears to be at odds with empirical evidence on low expected inflation predicting corporate defaults through its impact on real debt liabilities (Bhamra et al. (2011), Fiore et al. (2011), Gomes et al. (2016)), we conjecture that inflation — and its downward trend over the studied sample — contributes to explaining variations in default probabilities at the sector level by proxying for their trend component. Higher inflation volatility is associated with a significant decrease in default risk; consistent with the expectation that, in a low inflation environment, higher volatility would likely reduce the probability that firm will default due to higher real liabilities.[18]

Taken together, our results for the financial and non-financial sectors indicate that the beneficial effects of tighter macroprudential regulation on financial sector's default risk also transmit to the real economy by lowering both short- and long-term default risks on average. Our results thus complement and extend the analysis of Meuleman and Vander Vennet (2020) by confirming the main result of their bank-level analysis using aggregate data and by documenting the positive contribution of macroprudential regulation to improving the resilience of non-financial sectors of the economy. The transmission of the strengthening in financial stability to non-financial sectors of the economy is consistent with the literature documenting that a buildup of systemic risk in the financial sector increases downside risks to the real economy; see e.g. Allen et al. (2012), Giglio et al. (2016), and Brownlees and Engle (2017). Our findings that increased resilience in the financial sector has positive spillovers to

[18] Kang and Pflueger (2015) document a positive relationship between inflation volatility and corporate bond spreads using a panel of 6 countries over the period 1969 Q4 – 2010 Q4. Their analysis do not include the recent low inflation period on which we focus our analysis but our results are consistent with their debt deflation channel.

other sectors are also consistent with Azizpour et al. (2018) who document a cross-sectoral contagion channel in default clustering using US data.

4. Panel event-study on the transmission of macroprudential policy reforms

Having established that macroprudential regulation has a beneficial impact on average default risk in the financial and non-financial sectors of the economy, we now want to refine our analysis by investigating the impact of specific changes in the macroprudential framework on sector-specific probabilities of default. To this end, we focus on two major policy reforms which — due to their magnitude and scope of application at the EU level — provide us with an ideal setting to investigate the transmission of macroprudential policy to default risk at the sector level. The first one is the implementation of the Basel III standards into European law and the second one is the introduction of a European framework for the resolution of failing financial institutions.

We structure the exposition as follows: Section 4.1 details our empirical approach to analyse the dynamic effects of each policy event on sector-specific probabilities of default; Section 4.2 analyses the impact of the higher capital requirements introduced with Basel III; and Section 4.3 analyses the impact of a strengthening in the resolution framework and compares the main results for the two policy events.

4.1. The methodology

The panel-event study design allows us to estimate and analyze the dynamic effects of a policy intervention on an outcome variable of interest. The associated methodological literature has witnessed a substantial growth over the last few years; see e.g. Sun and Abraham (2021) for an overview. We estimate the following standard panel event-study regression with two-way fixed effects (TWFE) using the sector-specific probability of default at a horizon of 6 months and 5 years, $PD_{c,t}^{(h)}$, as the outcome variable:

$$PD_{c,t}^{(h)} = \sum_{j=\underline{j}}^{\bar{j}} \delta_j d_{c,t}^{j} + X_{c,t-1}^{\top} \beta + \mu_c + \theta_t + \nu_{c,t} \,, \tag{2}$$

where $d_{c,t}^{j}$ is a policy treatment indicator for an event taking place at a potentially country-specific time e_c located within an event window indexed by $j \in [\underline{j}, \bar{j}]$ ranging from $\underline{j} < 0$ periods before the event to $\bar{j} \geq 0$ after the event; $X_{c,t-1}$ is a vector of lagged macro-financial controls introduced in Section 3; μ_c is a country fixed effect accounting for cross-country differences in the average default probabilities; θ_t is a year fixed effect capturing overall trends in probabilities of default at the sector level; and $\nu_{c,t}$ is an error term. We follow the approach of Freyaldenhoven et al. (2019) and define the treatment indicator $d_{c,t}^j$ as follows:

$$d_{c,t}^j = \begin{cases} \mathbb{1}[t = e_c + j] & \text{if} \quad \underline{j} < j < \bar{j}\,, \\ \mathbb{1}[t \geq e_c + j] \times \text{sign}(j) & \text{if} \quad j \in \{\underline{j}; \bar{j}\}\,. \end{cases} \tag{3}$$

Borusyak et al. (2021) highlight an under-identification problem for dynamic treatment effects in fully dynamic panel event-study settings, i.e. using an event window which covers the entire set of observed data, as the dynamic treatment parameters δ_j cannot be separately identified from the time fixed effect θ_t. As shown by Schmidheiny and Siegloch (2019), restricting the event window to a finite length $[\underline{j}, \bar{j}]$ allows to circumvent this identification issue even in settings where all units are treated — which is the case in our empirical application. This comes however at a cost in terms of flexibility in the modelling of the dynamic effects of a policy intervention as it corresponds to assuming that the policy impact is constant outside the event window. An additional identification challenge arises from the perfect multicollinearity between the policy treatment indicators and the country fixed effect μ_c which requires to standardize one of the δ_j coefficients. We follow the standard approach in the literature and exclude the first lead of the treatment indicators, $d_{c,t}^{-1}$, which is equivalent to imposing the linear restriction $\delta_{-1} = 0$ in the estimation; see e.g. Freyaldenhoven et al. (2019). This implies that the coefficients δ_j, $\forall\, j \geq 0$, will be interpreted as the effect of the policy on the outcome variable j time periods after its introduction compared to the level of the outcome variable one period prior to the policy intervention. In addition, the model specified in Equation (2) implicitly restricts the dynamic effects of the policy treatment to be homogeneous across countries. Therefore, the estimates of the δ_j coefficients should be interpreted as the average pre-treatment (resp. post-) effect of the policy j periods before (resp. after) its introduction for all $j < 0$ (resp. $j \geq 0$) compared to the average level of the outcome variable one period prior to the policy intervention.

As pointed out in Schmidheiny and Siegloch (2019), the econometric identification of the panel event-study model specified in Equation (2) under the restrictions set out in the previous paragraph implicitly relies on either i) the existence of at least one never-treated unit, or ii) a setting with staggered treatment timing which enables a recursive identification by comparing a unit's treatment window endpoints with a control unit whose treatment window does not contain these time points. Given that our empirical analysis is based on a setting in which all countries are exposed simultaneously to the policy treatment, we need to impose an additional restriction to achieve identification and we thus exclude the second lead of the treatment indicators, $d_{c,t}^{-2}$, which is equivalent to imposing the linear restriction $\delta_{-2} = 0$ in the estimation.

Freyaldenhoven et al. (2019) highlight that a common concern in the assessment of the causal impact of a policy intervention on an outcome variable using a panel even-study setting is the potential endogeneity of the policy intervention due to the existence of confounding factors correlated with both the outcome variable and the likelihood of a policy intervention. Specializing to our analysis, the existence of confounding factors which simultaneously drive variations in sector-specific default risk and impact the likelihood of a change in the macroprudential policy stance would result in biased estimates of the dynamic effects of the policy intervention. A common diagnostic approach to address endogeneity concerns is to investigate — either visually or through a formal test on the coefficient estimates of the panel event-study model — whether the outcome variable appears to react to the policy intervention before the actual occurrence of the policy intervention; a phenomenon known as pre-event trend in the outcome variable. We follow this approach by testing the hypothesis of no pre-event trend as $\delta_{\underline{j}} = \delta_{\underline{j}+1} = \ldots = \delta_{-3} = 0$, which we complement with an hypothesis test on post-event trend formulated as $\delta_0 = \delta_1 = \ldots = \delta_{\bar{j}} = 0$.[19]

The next two subsections will apply the panel event-study methodology to analyze the impact on default risk at the sector level of two major changes in the European regulatory

[19] Freyaldenhoven et al. (2019) develop a 2-stage Least Square (2SLS) estimation approach which corrects the potential bias in estimated dynamic policy effects due to the presence of confounding factors even in the presence of pre-event trends in the outcome variable. We do not follow this approach in our analysis as no statistical evidence supporting the presence of pre-event trends in the sector-specific probabilities of default is found.

framework: i) the transposition of the Basel III package of measures into European law; and ii) the introduction of a regulatory framework for the resolution of failing banks. In both cases, we will consider an event window spanning 5 quarters before and after our chosen reference date for the policy event. This choice of event window allows to appropriately account for potential pre-event trends in sector-specific default risks and for the progressive transmission of announced changes in the macroprudential policy stance — see Section 3.1 for further details. Furthermore, we investigate the potential impact of the assumption of homogeneous dynamic policy effects across countries by conducting the analysis on the full sample of countries and on subsamples of euro area (EA) and non-EA countries.

4.2. Impact of higher capital requirements in the banking system.

The Basel III global standards were introduced in 2010 to address the lessons learned during the Global Financial Crisis of 2008 (BCBS (2010)). The reforms introduced were aimed at improving the ability of the financial system to withstand losses during periods of stress, thus reducing both the magnitude and likelihood of spillovers from the financial sector to the real economy — due e.g. to banks' procyclical deleveraging and the amplification role played by systemic institutions. The key measures to strengthen banks' loss-absorbing capacities were an increase in minimum requirements for going-concern Tier 1 capital from 4.5 to 6% of Risk-Weighted-Assets (RWA) — of which at least 4.5% were to be held in the form of Common Equity Tier 1 (CET1) capital — and the introduction of macroprudential capital buffers aimed respectively at promoting the conservation of capital (Capital Conservation Buffer, CCoB), increasing resilience against procyclicality (Countercyclical Capital Buffer, CCyB), addressing structural systemic risks (Systemic Risk Buffer, SRB), and imposing capital surcharges for global and domestic Systemically Important Institutions (G-SII and O-SII buffers).[20]

The Basel III standards were subsequently implemented in European law in June 2013 through the CRR/CRD IV package which was comprised of the Capital Requirements Regulation (CRR, Regulation 575/2013) and the Capital Requirements Directive (CRD IV, Directive 2013/36/EU). We choose this event date as our center point to construct the event

[20] All the capital buffer requirements have to be met with the highest level of capital quality (CET1).

window, ranging from March 2012 to September 2014, used in the panel event-study analysis. We consider that this event window is appropriate to capture the dynamic effects of increased capital requirements, including both minimum requirements and buffers, on sector-specific probabilities of default given the important concentration of policy announcement during this period. Indeed, 11 countries in our sample announced in June 2013 that the Basel III minimum capital requirements would be effective from January 2014.[21] The remaining countries announced at the same date that the new requirements would be effective from January 2015. Furthermore, 12 countries announced the implementation of a fully phased-in CCoB (2.5% of RWA) during the event window, among which 5 of them also activated at least one other capital buffer.[22]

Figure 1 summarises the evolution of the median probabilities of default around the introduction of the CRR/CRD IV package for the six sectors under analysis. First, we generally do not find statistical evidence supporting the hypothesis of a pre-event trend.[23] This mitigates concerns about a potential bias in the estimates of the dynamic policy effects due to endogeneity. Second, the introduction of the policy package impacted short-term default risks in a statistically significant way as we reject the null hypothesis of no post-event trend on the 6-month DPs in all cases. This impact is less pronounced for long-term default risks as we only reject the null hypothesis of no post-event trend on the 5-year DPs for the consumer cyclical and technology sectors.

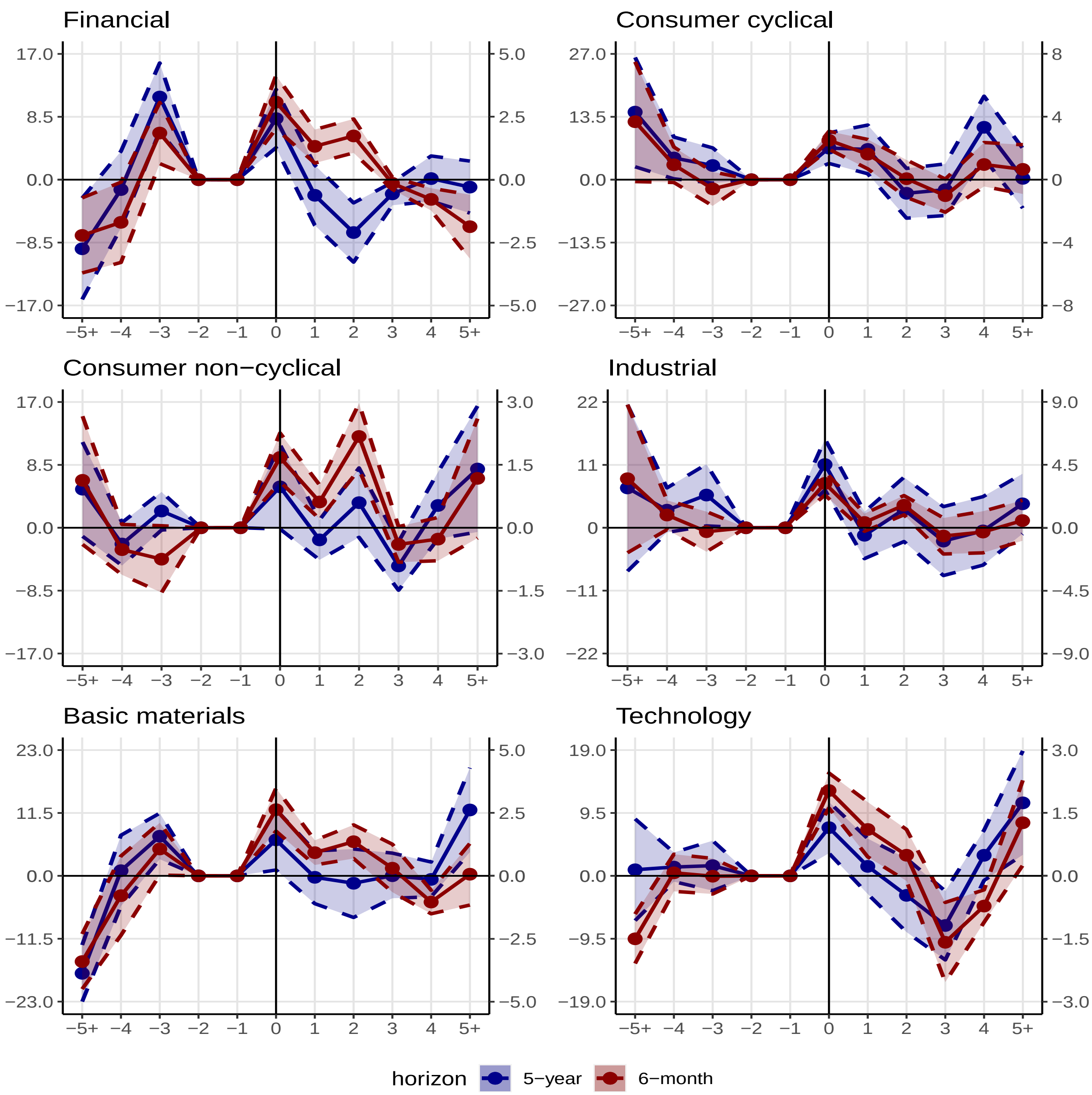
We now inspect in more details the impact of the introduction of the CRR/CRD IV policy package on default risks at the sector level. We observe an increase in both short- and long-term default risks around the event. The impact on 6-month DPs ranges from a 1.68 bps increase for the consumer non-cyclical sector to respectively 3.08 and 3.18 bps increases for the financial and industrial sectors. For the 5-year DPs, the impact ranges from a 5.53 bps increase for the consumer non-cyclical sector to respectively 8.26 and 11.05 bps increases

[21]The countries were Bulgaria, Estonia, Finland, Greece, Italy, Luxembourg, Latvia, Malta, the Netherlands, Romania, and Sweden.

[22]For the CCoB, the countries were Austria, Bulgaria, Cyprus, Czech Republic, Estonia, Finland, Hungary, Italy, Luxembourg, Latvia, Sweden, and Slovakia. Bulgaria, Czech Republic, Estonia, Hungary, and Sweden also activated their SRB during the period studied. Finally, Sweden set a 1% CCyB in September 2014.

[23]Notable exceptions are the 5-year DP for the consumer cyclical sector (p-val of 0.077) and the 6-month DPs for the basic materials and technology sectors (p-vals of 0.027 and 0.00 respectively).

Figure 1: Impact of the introduction of CRR



Note: This figure summarises the evolution of the median probabilities of default around the introduction of the CRR/CRD IV package for the six sectors analysed. The event window captures a period of 10 quarters around the event (x-axis). The y-axes display the estimated coefficients for the event window as specified in equation (2). The results for the 5-year (6-month) default horizon are reported in blue (red) with corresponding value on the left-hand (right-hand) y-axis. The shaded areas around the point estimates correspond to the 68% confidence intervals constructed based on standard errors clustered at the country level. The estimation is carried out on the full sample of countries.

for the financial and industrial sectors. The rise in default risk following the introduction of the regulatory package is also economically significant as a comparison with the median PD levels reported in Table 1 indicates that they translate into increases above median levels from 34% (consumer non-cyclical sector) to 62% (financial sector) for the 6-month default horizon, and from 4% (basic material sector) to 7% (financial sector) for the 5-year default horizon. An analysis of the impact of the policy change at a longer horizon provides evidence of a disconnect between the financial sector and non-financial ones. On the one hand, the default risk of the financial sector decreases progressively in the post-event period with e.g. a decrease of 7.14 bps for the 5-year DP two quarters after the event. The long-run impact of the introduction of the CRR/CRD IV package, captured by the estimate of δ_{5+} in equation (2), is a decrease in default risk by respectively 1.88 and 1 bps for the 6-month and 5-year DPs. The reduction in short-term default risk is particularly substantial as it corresponds to a 38% decrease compared to the median level. Non-financial sectors, on the other hand, appear to experience a sustained increase in default risk following the introduction of the policy package.[24] The effect is particularly pronounced for long-term default risk, as the long-run impact on the 5-year DPs ranges from 4.19 bps (industrial sector) to 12.05 bps (basic material sector) — corresponding to increases above median levels ranging from 2.5 to 7.6%. The consumer non-cyclical and technology sectors also experience a marked increase in short-term default risk with a long-run increase of their 6-month DPs of respectively 1.18 and 1.27 bps — a 24% increase compared to their median levels.

The results for the financial sector are consistent with the intuition that increasing capital requirements can raise concerns in the short-term about the ability of financial institutions, in particular those which are less well-capitalized and/or less profitable, to meet increased standards of resilience. This leads to an increase in default risk in the early stage of the introduction of the policy package. However, the initial increase in default risk is progressively reversed as the CRR/CRD IV package leads to a strengthening in the resilience of the financial system and therefore reduces default risk in the long run. This is consistent with the long-run analysis in Jordà et al. (2020) showing how better capitalized banking systems are

[24]The consumer cyclical sector is however not affected by this trend.

better equipped to withstand losses during banking crises, thus enabling banks to maintain a more stable supply of credit to the real economy and leading to shorter-lived economic downturns. The concurrent increase in default risk for non-financial sectors is also consistent with the literature studying how banks adjust their balance sheets in reaction to higher capital requirements and the implications for the real economy. When banks are faced with higher capital requirements, expressed in terms of CET1 capital to RWA, they are reluctant to meet them with higher equity levels and prefer instead considering options to shrink their RWA. This can be achieved through both a reduction in balance sheet exposure to retail and corporate borrowers (Gropp et al. (2018)) and a reduction in average risk weights — e.g. via a reallocation of credit supply from corporates to households (Juelsrud and Wold (2020)). Firms are not always able to substitute this reduction in credit supply with alternative sources of funding and this reduced access to credit thus negatively impact the real economy through lower investment, employment, asset growth and sales (Gropp et al. (2018), Fraisse et al. (2020)). We complement these evidence on the real effects of higher capital requirements by documenting that the increase in default risk of the non-financial sectors is mainly apparent in long-term default risk, which likely reflects concerns about a structural change in access to credit after the phasing-in of the new regulatory regime. The consumer non-cyclical and technology sectors also show signs of increased short-term default risk which could mean that they are more vulnerable to a reduced credit supply from banks. Our findings also provide supporting empirical evidence to the literature highlighting how short-term transitional costs, e.g. through a reduction in credit supply and aggregate demand, can partially offset the long-term benefits of higher capital requirements arising from improved resilience in the financial system; see e.g. Mendicino et al. (2020).

We investigated the robustness of our results by re-estimating Equation (2) on the sub-samples of EA (euro area) and non-EA (non-euro area) countries. Results are reported respectively in Figures 3 and 5 of Appendix A. For EA countries, we confirm our previous result of a lack of statistical evidence supporting the existence of a pre-event trend.[25] For non-EA countries, we find statistical evidence supporting a pre-event trend both in short-

[25] The null hypothesis of no pre-event trend is only rejected for the 6-month DPs of the financial and technological sectors.

and long-term default risks for the basic material, consumer cyclical, and financial sectors. It is important to note that the existence of a pre-event trend in financial sector's default risk is not necessarily due to the presence of confounding factors potentially biasing the estimation of the dynamic policy effects over the event window. The relatively long implementation cycle of the Basel III package — from the initial agreement of the BCBS in 2010 to the effective introduction of the policy reforms between 2013 and 2015 — results in financial institutions, especially the non-EA ones, adjusting their behavior in anticipation of future policy changes, which would in turn be reflected in their default risk at the sector level. Our main conclusions on the statistically and economically significant impact of the policy change on default risk are confirmed in the EA sub-sample but not in the non-EA one.

4.3. Impact of a strengthening in the resolution framework for failing banks

The Bank Recovery and Resolution Directive (BRRD, Directive 2014/59/EU) was introduced in May 2014 to provide a European framework to address failing banks at the national level and to promote a better coordination when dealing with cross-border banking failures. The BRRD represents the culmination of legislative efforts in the post-GFC period to transition away from a bailout regime, which relies heavily on recapitalizations from the public sector whose costs are eventually supported by tax payers, and towards a bail-in regime in which shareholders and creditors bear losses first and the public restructuring option is only considered after the application of the bail-in tool. The Directive aimed at ensuring a timely and efficient resolution of failing banks that would mitigate the risks of a significant adverse impact on other financial institutions and the real economy.[26] To this end, the key elements set out in the BRRD were the introduction of recovery and resolution planning to prepare for the resolution of failing banks through an adequately designed strategy; and providing resolution authorities with legal powers to intervene and resort to resolution tools in cases where a financial institution is at risk of failing.[27]

[26]See Article 31(2) of the Directive for a complete list of objectives.

[27]The set of resolution tools granted to authorities includes i) the sale to independent third parties of shares, assets, and liabilities of the failing institution; ii) the transfer of those to a fully- or partially-public legal entity (bridge institution); iii) transferring the management of the assets and liabilities of the failing institution to a publicly-owned asset management vehicle (special purpose vehicle); and iv) the ability to write down/off capital instruments and to convert existing debt instruments into equity to restore sufficient

We choose December 2014, the latest date for the transposition of the BRRD into national laws, as our center point to construct the event window — which ranges from September 2013 to March 2016 — for the panel event-study analysis. We consider that this event window is appropriate to capture the dynamic effects of a strengthening in the resolution framework on the default risk of the financial and non-financial sectors of the economy for two reasons. First, the event window includes the key moments of the implementation of the resolution package as, in addition to the adoption of the directive in European law, it covers both the period around January 2015 — where BRRD's provisions not related to the implementation of the bail-in tool came into force — and the period around January 2016 where the Directive became fully binding for the regulation of EU banks' bail-ins. Second, Cutura (2021) documents that the threat of an enforcement of bail-in powers by resolution authorities was perceived as credible by investors given that banks' unsecured corporate bonds maturing after January 2016, and thus subject to the bail-in tool, started trading with a positive spread over their control group, i.e. unsecured corporate bonds from the same issuers but maturing before 2016, following the introduction of the BRRD.

Figure 2 details the evolution of the median probabilities of default of the different sectors around the introduction of the BRRD. Similar to our results presented in the previous section, we do not find statistical evidence supporting the presence of a pre-event trend in default risk prior to the introduction of the policy. We observe a rather muted impact of the introduction of the policy package in the short-run followed by a substantial long-run reduction in both short- and long-term default risks in all sectors. The reduction in the 6-month PDs ranges from 2.09 bps for the consumer cyclical sector to 3.77 bps for the financial sector; and up to 4.78 bps for the industrial sector.[28] Decreases in the 5-year PDs are comprised between 9.30 bps for the consumer non-cyclical sector and 20.44 bps for the financial sector. These reductions in default risk are sizeable as a comparison with figures in Table 1 shows that they

capitalization while avoiding bankruptcy proceedings (bail-in tool). See Philippon and Salord (2017) for a comprehensive overview of the BRRD.

[28]The basic materials sector experiences substantial reductions in default risk — of respectively 9.62 bps and 46.5 for the 6-month and 5-year PDs — following the introduction of the BRRD. Given the magnitude of the impact relative to the one for the financial sector, which serves as our benchmark, we decided not to elaborate on these results in the body of the text as they are likely to be driven to some extent by external factors outside the scope of our analysis.

translate into decreases below median PD levels ranging respectively from 47% (technology sector) to 76% (financial sector) for the 6-month DPs, and from 6.7% (technology sector) to 17.3% (financial sector) for the 5-year DPs.

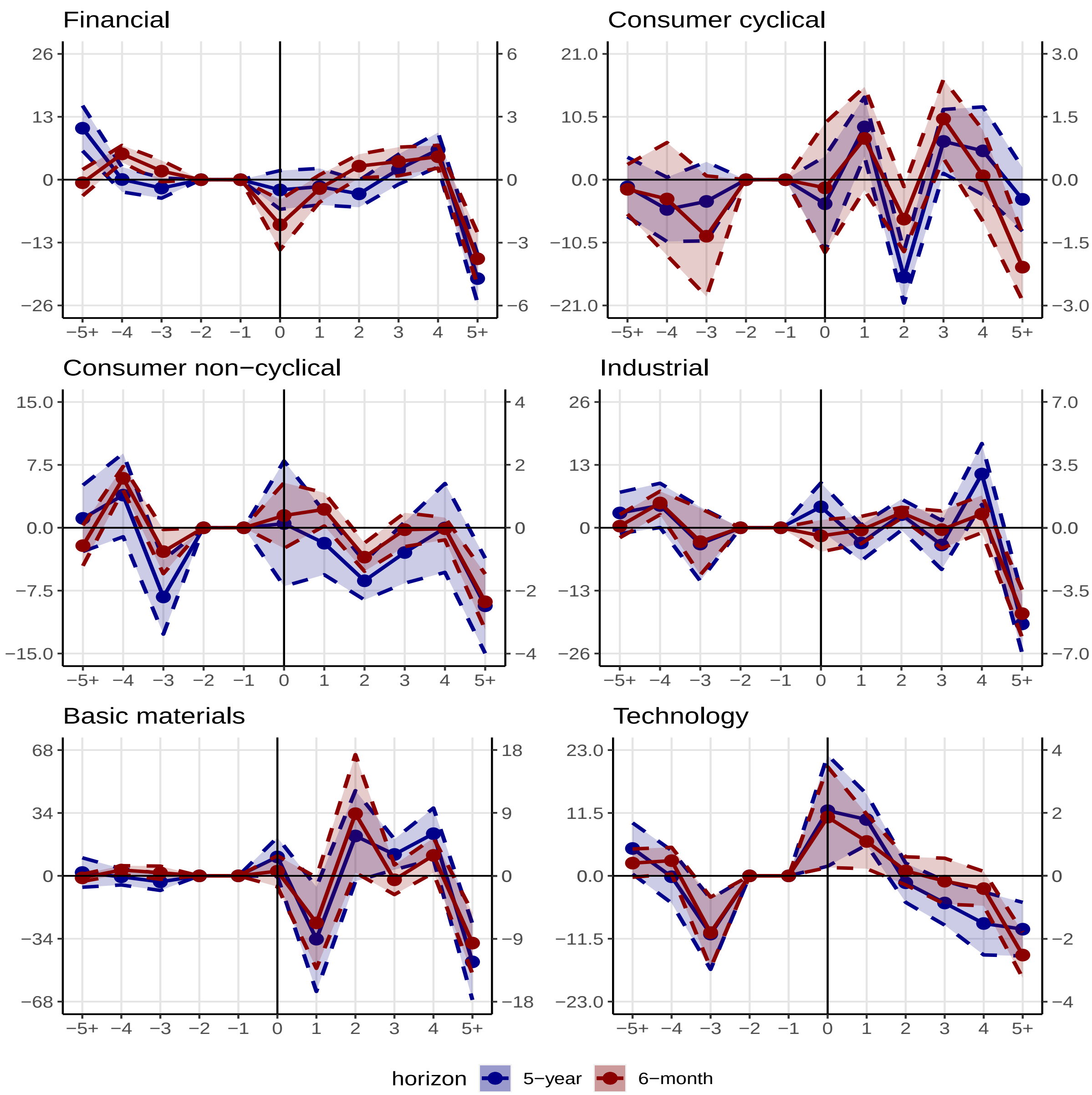
The results for the financial sector are consistent with the findings in Cutura (2021) that the perceived credibility of the newly introduced bail-in framework led to increased market discipline and a decrease in banks' risk taking reflected in a reduction in balance sheet's exposures to impaired and non-performing loans.[29] Our results suggest that the resulting improvement in the quality of banks' balance sheets, which translates into reduced funding cost on BRRD-sensitive instruments, also leads to lower default risk at the sector level. As the BRRD credibly increased investors' expectations about the likelihood of bail-ins, our results also provide supporting evidence on how transitioning away from a bailout regime — and its associated implicit government guarantees — can reduce banks' risk taking and improve financial stability through a reduction in financial sector's default risk; see e.g. Dam and Koetter (2012) and Duchin and Sosyura (2014) for evidence on respectively how bailout expectations and actual government recapitalizations increase banks' risk taking and default risk due to moral hazard.

The positive impact of a strengthened resolution framework on financial stability spills over to the default risk of non-financial sectors of the economy. This result is consistent with Altunbas et al. (2010) who document empirically that less risky banks, as measured by their ex-ante 1-year expected default frequency, are able to supply more credit due to their better performance prospects and easier access to uninsured funding. Our results thus suggest that the BRRD also had a positive impact on default risk in the non-financial sector through an improvement in access to credit resulting from the healthier balance sheet composition of the financial sector.

We provide the results for the robustness check on the subsamples of EA and non-EA countries in Figures 4 and 6 of Appendix A. The main conclusions of our analysis are confirmed in both subsamples but we observe a lower level of precision in the estimates of the policy impact for the non-EA subsample. This result can be explained by the relatively

[29]The author notes that the pattern is more pronounced for banks whose unsecured corporate bonds are more sensitive to the introduction of the BRRD, e.g. due to their lower capitalization levels.

Figure 2: Impact of the introduction of BRRD



Note: This figure summarises the evolution of the median probabilities of default around the introduction of the BRRD package for the six sectors analysed. The event window captures a period of 10 quarters around the event (x-axis). The y-axes display the estimated coefficients for the event window as specified in equation (2). The results for the 5-year (6-month) default horizon are reported in blue (red) with corresponding value on the left-hand (right-hand) y-axis. The shaded areas around the point estimates correspond to the 68% confidence intervals constructed based on standard errors clustered at the country level. The estimation is carried out on the full sample of countries.

smaller cross-section of countries available in this subsample and the higher degree of heterogeneity between them.

Finally, it is useful to end this section by contrasting our results for the impact of the BRRD with the one obtained in Section 4.2 for the CRR/CRD IV package. Our analysis suggest that regulatory reforms incentivising banks' shareholders and creditors to monitor their risk-taking behaviour, such as the implementation of a credible bail-in framework for resolution, might be more effective in reducing default risk in the financial sector than measures targeting banks' loss-absorbing capacities through increased capital targets once the impact on the non-financial sectors of the economy is factored in. Indeed, the transmission of policy interventions to the default risk of the non-financial sectors is likely to be determined by how banks' credit supply is impacted by the policy. On the one hand, banks' react to higher capital requirements by reducing their RWA rather than increasing capital and the resulting reduction in credit supply increases default risk in non-financial sectors. On the other hand, the increased market discipline brought about by a strengthening in the resolution framework lowers banks' risk and increase their ability to supply credit, thereby contributing to a reduction in default risk of the non-financial sectors.

5. Conclusion

We provide a comprehensive analysis of the transmission of macroprudential regulation across both financial and non-financial sectors of the economy through the lens of its impact on short- and long-term probabilities of default at the sector level.

Combining a detailed database on macroprudential policies in European countries with data on probabilities of default for financial and non-financial sectors, we first investigate whether tighter macroprudential regulation also transmits to non-financial sectors of the economy and whether its impact is beneficial or detrimental. We find that tighter macroprudential regulation is beneficial to non-financial sectors of the economy on average and that the significance of the reduction in default risk — both economically and statistically — is comparable to the results obtained for the financial sector.

We then analyse how specific reforms in the macroprudential framework dynamically impact default risk in the financial and non-financial sectors. To this end, we study two important macroprudential reforms taking place at the European level: the phasing in of the Basel III standards on capital requirements, and the introduction of a resolution framework for failing banks. We find that higher capital requirements improve the resilience of the financial sector in the long run but at the cost of raising long-term default risk in non-financial sectors. On the contrary, a strengthening in the resolution framework has beneficial long-run effects on short- and long-term default risks of the financial and non-financial sectors. Our findings are consistent with papers documenting how banks adjust their balance sheet composition and credit supply in reaction to changes in their regulatory environment. However, an in-depth analysis of the effective channels of transmission is beyond the scope of the current paper and left for future research.

An important policy implication of our paper is that, although macroprudential regulation has on average beneficial effects on default risk in non-financial sectors, the impact of a policy reform can vary depending on the chosen instrument. Indeed, our results suggest that regulatory reforms incentivising better risk monitoring of banks by their shareholders and creditors might be more effective in reducing default risk in the financial sector than measures targeting banks' loss-absorbing capacities through increased capital targets — once the impact on default risk in the non-financial sectors default risk is taken into account. This is due to the fact that the transmission of a policy reform to the default risk of non-financial sectors is likely determined by how banks adjust their behaviour and credit supply in reaction to the policy change.

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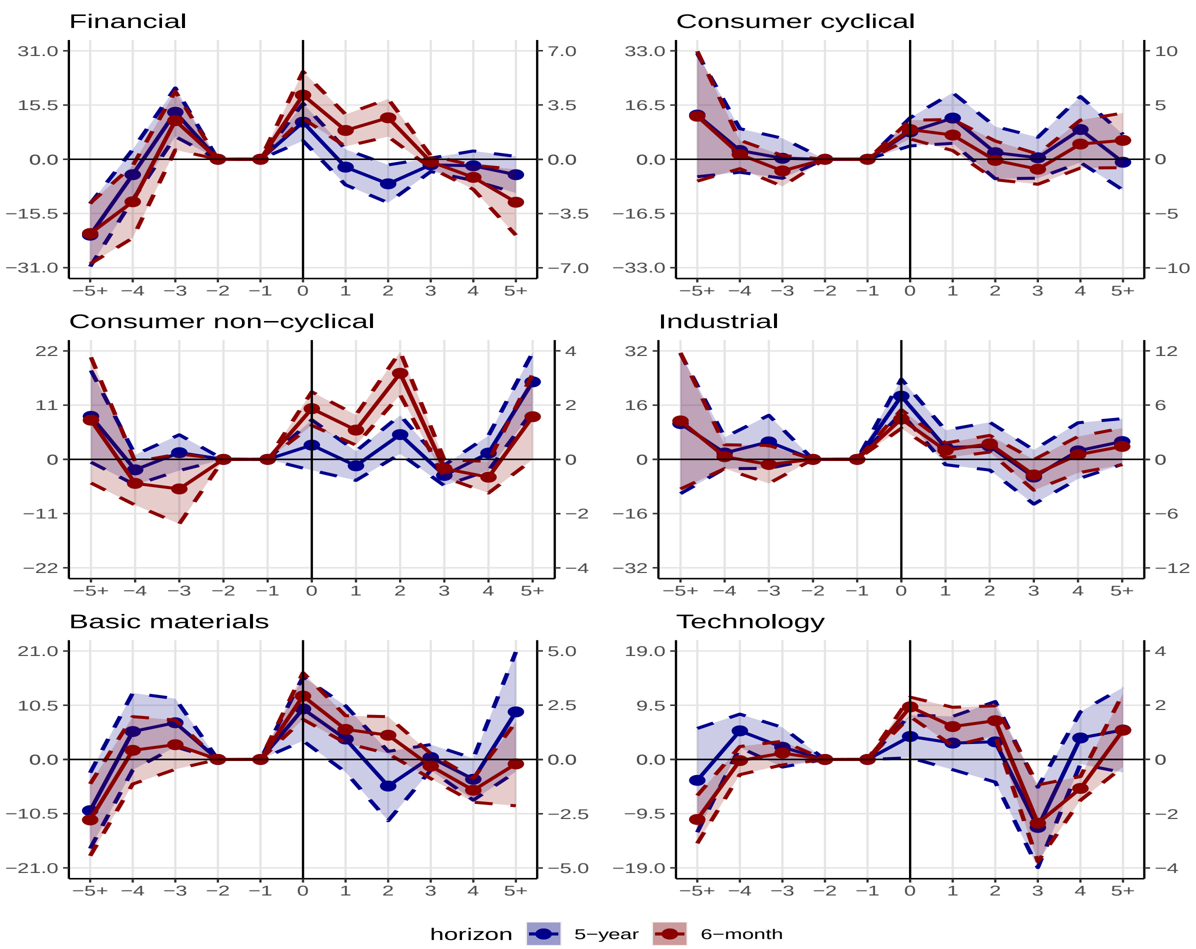
Appendix

A. Additional results for the main analysis

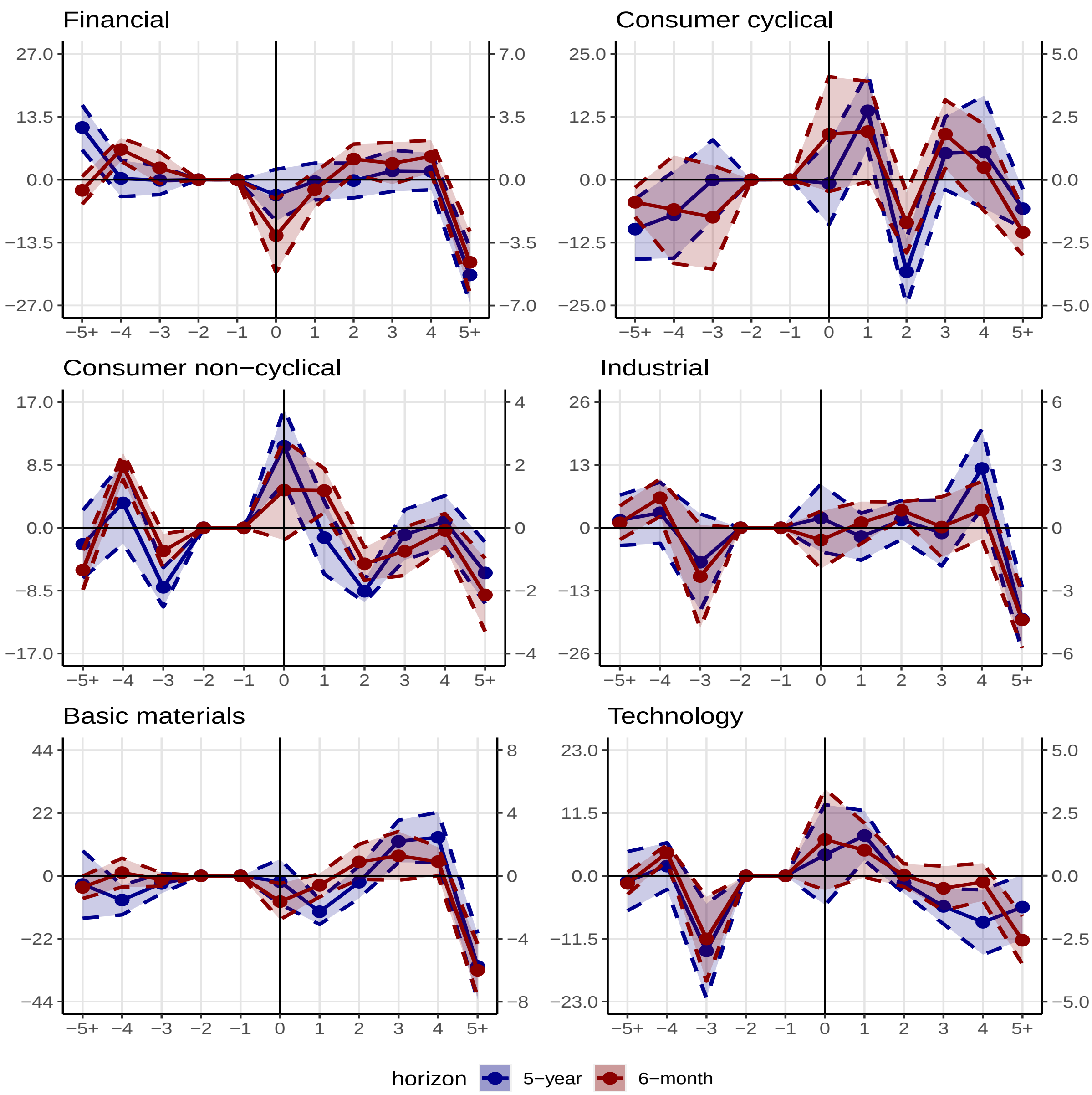
A.1. Panel even-study results for the subsample of EA countries

Figure 3: Impact of the introduction of CRR/CRD IV (EA countries)



Note: This figure summarises the evolution of the median probabilities of default around the introduction of the CRR/CRD IV package for the six sectors analysed. The event window captures a period of 10 quarters around the event (x-axis). The y-axes display the estimated coefficients for the event window as specified in equation (2). The results for the 5-year (6-month) default horizon are reported in blue (red) with corresponding value on the left-hand (right-hand) y-axis. The shaded areas around the point estimates correspond to the 68% confidence intervals constructed based on standard errors clustered at the country level. The estimation is carried out on the subsample of EA countries.

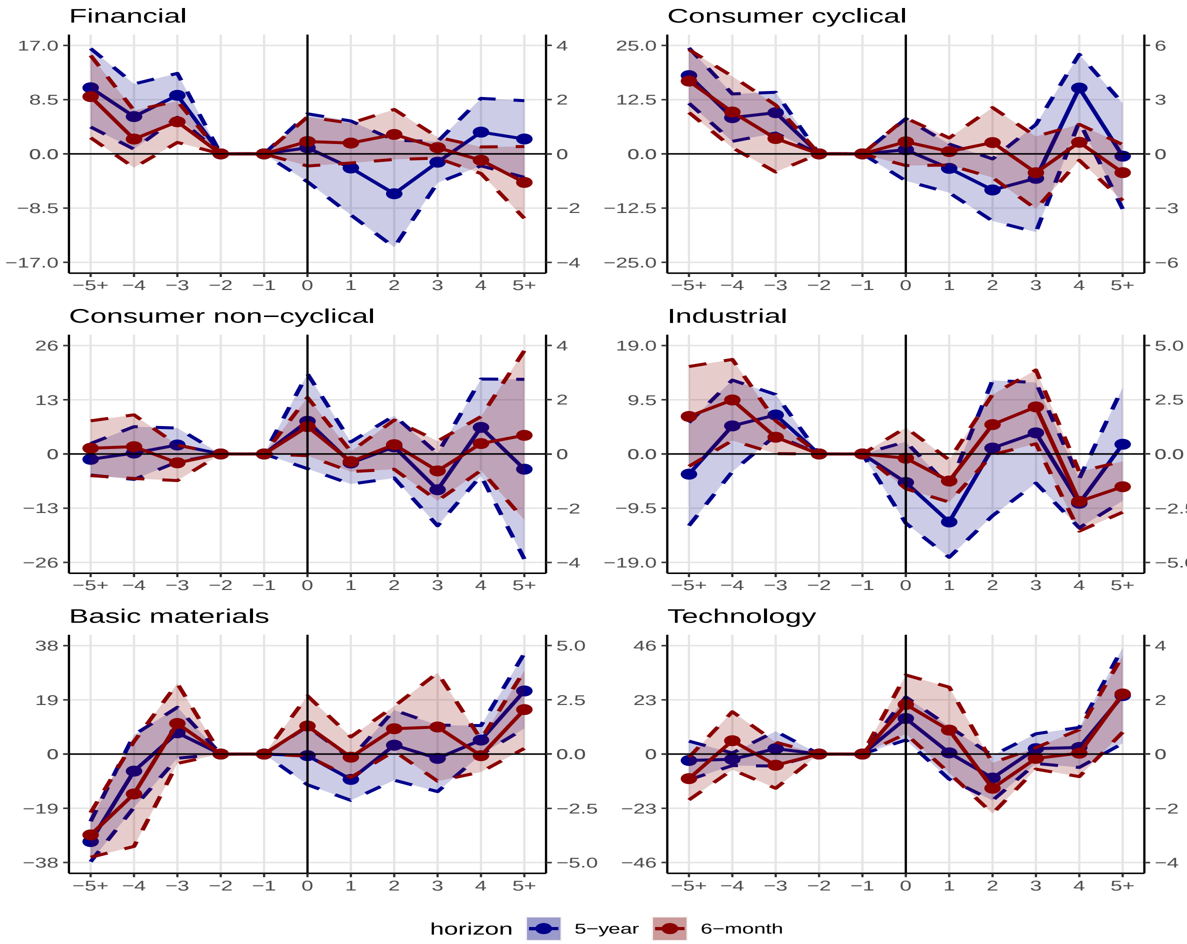
Figure 4: Impact of the introduction of BRRD (EA countries)



Note: This figure summarises the evolution of the median probabilities of default around the introduction of the BRRD for the six sectors analysed. The event window captures a period of 10 quarters around the event (x-axis). The y-axes display the estimated coefficients for the event window as specified in equation (2). The results for the 5-year (6-month) default horizon are reported in blue (red) with corresponding value on the left-hand (right-hand) y-axis. The shaded areas around the point estimates correspond to the 68% confidence intervals constructed based on standard errors clustered at the country level. The estimation is carried out on the subsample of EA countries.

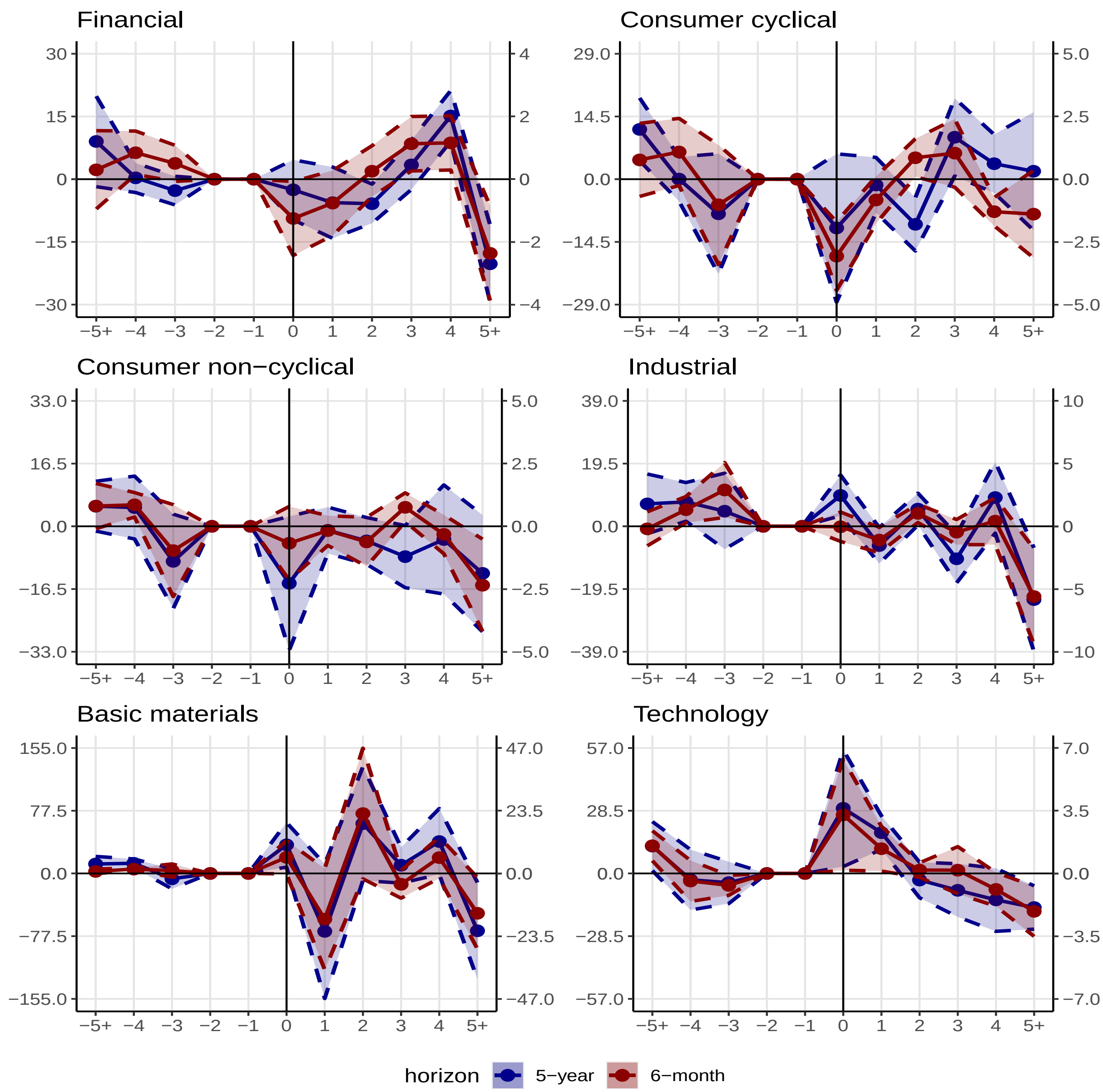
A.2. Panel even-study results for the subsample of Non-EA countries

Figure 5: Impact of the introduction of CRR/CRD IV (Non-EA countries)



Note: This figure summarises the evolution of the median probabilities of default around the introduction of the CRR/CRD IV package for the six sectors analysed. The event window captures a period of 10 quarters around the event (x-axis). The y-axes display the estimated coefficients for the event window as specified in equation (2). The results for the 5-year (6-month) default horizon are reported in blue (red) with corresponding value on the left-hand (right-hand) y-axis. The shaded areas around the point estimates correspond to the 68% confidence intervals constructed based on standard errors clustered at the country level. The estimation is carried out on the subsample of non-EA countries.

Figure 6: Impact of the introduction of BRRD (Non-EA countries)



Note: This figure summarises the evolution of the median probabilities of default around the introduction of the BRRD for the six sectors analysed. The event window captures a period of 10 quarters around the event (x-axis). The y-axes display the estimated coefficients for the event window as specified in equation (2). The results for the 5-year (6-month) default horizon are reported in blue (red) with corresponding value on the left-hand (right-hand) y-axis. The shaded areas around the point estimates correspond to the 68% confidence intervals constructed based on standard errors clustered at the country level. The estimation is carried out on the subsample of non-EA countries.