The European Journal of Finance

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rejf20

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To cite this article: Stefano Filomeni & Konstantinos Baltas (2022): Senior-subordinated structure: buffer or signal in securitisation?, The European Journal of Finance, DOI: 10.1080/1351847X.2022.2052140

To link to this article: https://doi.org/10.1080/1351847X.2022.2052140

Published online: 23 Mar 2022.

THE EUROPEAN JOURNAL OF FINANCE
https://doi.org/10.1080/1351847X.2022.2052140

Senior-subordinated structure: buffer or signal in securitisation?

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ABSTRACT
By exploiting a unique and proprietary dataset comprising granular deal- and tranche-level data on a global portfolio of securitisation deals, we empirically test the buffer vs the signalling hypothesis of credit enhancements in securitisation. We do so by focusing on one internal credit enhancement associated with the design of financial securities in securitisation, i.e. subordination. This study provides novel evidence on the role played by subordination in securitisation, suggesting that a real dichotomy between the buffer and signalling effects does not hold. Our findings indeed highlight that subordination serves both as a buffer against observable risk and as a signal of unobservable credit quality to third-party investors in the market; moreover, our results are robust to a wide battery of robustness tests. Our findings, of international relevance, contribute to the literature on information asymmetries between originators and investors and offer new policy insights in light of the recent agreement reached by European lawmakers with national governments to revive the European securitisation market.

ARTICLE HISTORY
Received 30 December 2020
Accepted 21 February 2022

KEYWORDS
Securitisation; subordination; buffer; signalling; delinquency; rating; mortgage market

JEL CLASSIFICATIONS
D82; G21; G24

1. Introduction

The relevance of securitisation as a structured finance instrument was recently confirmed by the deal reached in 2017 by the European Commission[1] with national governments with the purpose of revitalising the continent's securitisation market, paving the way towards freeing up bank lending so that more financing can go towards supporting companies and households.[2] The deal is seen as one of the cornerstones of the Capital Markets Union (CMU), a pivotal project aiming to build a single market for capital in the European Union by the end of 2019. Establishing a capital market that is fully connected, autonomous, and well-integrated across the European Economic Area is critical to ensuring a thriving European economy. One of the key factors to build a strong and resilient European capital market is to have a flexible, sound, and comprehensive securitisation market. As a matter of fact, a well-functioning and liquid securitisation market allows banks to free up capital and thus represents a promising avenue to enhance their lending capacity to households and to the corporate sector. Within the corporate sector, such an increased bank lending capacity is of particular relevance for more financially-constrained SMEs, in a context where the latter are often hailed as an important engine of economic growth (Banerjee 2014). Indeed, SMEs often have difficulty to obtain bank financing to fulfil their cash flow and investment needs, and banks typically hold large stocks of relatively illiquid SME loans that hinder their capacity to engage in further SME lending (Berger and Udell 1998; Beck, Demirguc-Kunt, and Maksimovic 2005; Ferrando and Griesshaber 2011; Nuzzo 2017). Via securitisation, those illiquid loans can be transformed into liquid and marketable securities and sold to third-party investors, thus allowing originating banks to free up capital that, in turn, spurs further SME lending and thus supports the viability and growth of SMEs in the marketplace (Anton and Bostan 2017; Anton 2019) (Figure 1).[3]

It is widely known that every securitisation deal typically involves the presence of credit enhancements, whose nature can be internal or external (European Parliamentary Research Service 2015)[4] and which are used both to

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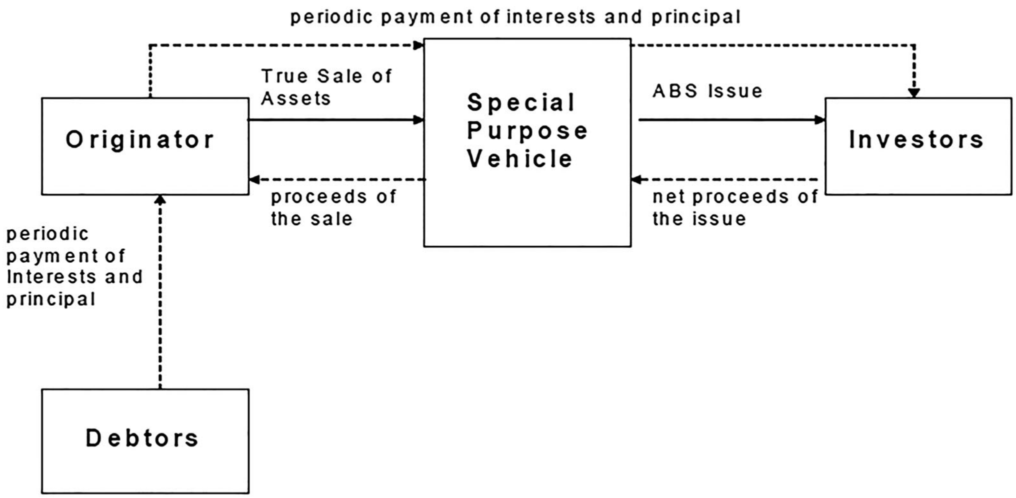

Figure 1. Main cash flows in a securitisation deal.

Notes: Figure 1 provides a visual representation of a typical securitisation process, where the originator sells a pool of assets to a Special Purpose Vehicle (SPV) that pays back the originator by issuing, to either private or institutional investors, asset-backed securities (ABS) in which the reimbursement of coupons and principal is strictly connected to the expected cash flows generated by the underlying debtors. Source: Filomeni (2011).

protect investors against predictable and unforeseen events during adverse conditions and to mitigate information asymmetry endemic to securitisation (Standard and Poor's 2008; European Parliamentary Research Service 2015). The role played by credit enhancements in securitisation is therefore of crucial importance to revive the securitisation market not only to adequately protect investors in a manner consistent with their risk profiles but also to reach a stronger alignment of interests between originators and third-party investors in the market; indeed, a more sound and enhanced framework for securitisation activity prevents from reviving the deficiencies revealed during the 2007–2009 financial crisis, deficiencies which have hampered the continued growth and efficiency of the securitisation market (Filomeni 2011, 2022).

The scarcity of the existing literature that examines the role of credit enhancements in securitisation motivates us to further investigate this field of research. Specifically, we do this by focusing on one specific internal credit enhancement associated with security design, the so-called senior-subordinated structure, commonly labelled subordination (Deku, Kara, and Marques-Ibanez 2019a, 2019b).[5] Subordination refers to the par value of tranches in securitisation with claims junior to the tranche in question (relative to the par value of collateral) and represents the maximum level of loss that could occur immediately without investors in the tranche losing one dollar of interest or principal (Ashcraft and Schuermann 2008). The reason underlying our choice to examine subordination is that, to the best of our knowledge, there are no previous studies that investigate the buffer-signalling motivation behind the design of the senior-subordinated structure commonly present in residential mortgage-backed securitisation (RMBS). Indeed, RMBS typically have a senior-subordinated structure, where mortgage principal payments are first paid to senior tranches (that have the highest credit ratings, are last in line to absorb credit losses, and pay the lowest yields to investors), while realised mortgage losses are first applied to the junior claims among which the most junior class is represented by the equity tranche (Ashcraft, Vickery, and Goldsmith-Pinkham 2010).

We test for the role played by the senior-subordinated structure in securitisation by drawing on two arguments proved by the extant literature. Firstly, according to the 'buffer' hypothesis, subordination helps to protect the senior tranche from the 'observable risk' embedded in the estimated loss function on the underlying securitised assets. Indeed, the 'buffer' hypothesis postulates that higher subordination levels are associated with a higher degree of observable risk in a context where subordination represents a protection mechanism that senior and mezzanine tranche investors have against credit losses on the underlying mortgage loans (Ashcraft and Schuermann 2008; Ashcraft, Vickery, and Goldsmith-Pinkham 2010; Mandel, Morgan, and Wei 2012).[6] Secondly, according to the 'signalling' hypothesis, subordination acts as a costly signal of the unobservable credit risk of the underlying loan pool to third-party investors in the market, in a setting where issuers have private information about the quality of the mortgages. Indeed, the 'signalling' hypothesis advocates that higher subordination levels are associated with higher unobservable risk in a context where issuers send a costly signal of unobservable credit risk by reducing the size of the more favourably priced, and highly-rated, senior tranche to mitigate information asymmetry (Begley and Purnanandam 2016). Therefore, originators provide greater subordination in order to 'market' a specific securitisation deal and make it more appealing to the eyes of investors in the market, as the former are more informed than the latter about the creditworthiness of final debtors (James 2010; Albertazzi et al. 2011).

To investigate the aforementioned 'buffer' and 'signalling' arguments, we exploit a novel dataset comprising granular deal- and tranche-level data on a global portfolio of 100 RMBS securitisation deals originating in nine countries and closing between 2005 and 2007.[7] The data at our disposal are collected from the Standard & Poor's Global Credit Portal database. Their quality and granularity allow for the collection of detailed quantitative and credit rating information not only at the deal level, but also at the tranche level. In particular, among the other factors, for each tranche of a deal we observe not only the credit ratings attributed by Standard and Poor's, but also the degree of subordination provided by the outstanding principal balances of more junior classes and expressed as a percentage of the deal's outstanding principal balance (Ashcraft, Vickery, and Goldsmith-Pinkham 2010; Deku, Kara, and Marques-Ibanez 2019a).[8]

To the best of our knowledge, there are no existing studies that test for both the 'buffer' and the 'signalling' effects of subordination in securitisation. The current literature has rather examined the role of credit enhancements in securitisation by focusing on the use of tranche retention as a signalling device to mitigate asymmetric information in securitisation (Albertazzi et al. 2011; Downing, Jaffee, and Wallace 2009; James 2010; Mandel, Morgan, and Wei 2012). Nonetheless, we are aware of only two other papers that investigate this buffer-signalling dual role of credit enhancements in securitisation. In this regard, our overall results are consistent with their findings that enhancement provisioning could serve as both a buffer against quantifiable risk and a signal of unobservable credit quality. However, our study significantly differs from those papers in several aspects, as explained in the following paragraphs.

On the one hand, using loan-level data matched with security level information, Ashcraft, Vickery, and Goldsmith-Pinkham (2010) find that the amount of AAA subordination is positively associated with delinquency on underlying US subprime and Alt-A mortgage pools. Our findings confirm this result as they are indeed consistent with the 'buffer' hypothesis according to which subordination is used as a buffer against observable credit risk. Interestingly, Ashcraft, Vickery, and Goldsmith-Pinkham (2010) also find that BBB subordination is negatively associated with mortgage performance on Alt-A deals, which they consider more opaque and, as such, hard-to-rate. The latter result seems consistent with the 'signalling' hypothesis according to which the issuer of an opaque security submits to a high degree of subordination to signal its confidence in the quality of the assets it is selling. However, the authors also show that BBB subordination is positively associated with ex-post rating downgrades on initial credit ratings, used by the authors as an alternative measure of deal performance. This latter result seems to conflict with the 'signalling' argument of subordination and to contrast with the aforementioned authors' previous result. Therefore, to the specific purpose of this paper, Ashcraft, Vickery, and Goldsmith-Pinkham (2010)'s findings provide mixed, inconclusive evidence on the use of subordination as a 'signalling device' to mitigate asymmetric information endemic to securitisation.

On the other hand, using US bank holding company (BHC) data, Mandel, Morgan, and Wei (2012) find evidence that the buffer effect and the signal hypothesis of credit enhancement provisioning could both be at play in securitisation. However, differently from our paper, in Mandel, Morgan, and Wei (2012)'s setting subordination is a measure of risk retention by BHCs and not necessarily represents a credit enhancement for a securitisation deal. It follows that

> a deal could have 20 percent subordination (say, a $1 billion mortgage pool divided into an $800 million senior bond and a $200 million junior bond) without the BHC holding (retaining) any of the subordinated piece. In that case, the enhancement would not show up in our data. (Mandel, Morgan, and Wei 2012)

Therefore, Mandel, Morgan, and Wei (2012)'s analysis is dependent on the degree of tranche retention by the originator. To the contrary, we use detailed deal- and tranche-level data (rather than aggregate data collected at the BHC level) and focus our analysis on the subordination level provided by each individual tranche of a securitisation deal (rather than on the subordinated claim held at the BHC level which might not be representative of the true senior-subordinated structure of a deal). Moreover, Mandel, Morgan, and Wei (2012)'s analysis lacks a specific focus on subordination as it is centred on the aggregate value of total credit enhancements provided to a securitisation deal by BHCs.

Moreover, as opposed to Ashcraft, Vickery, and Goldsmith-Pinkham (2010) and Mandel, Morgan, and Wei (2012) that focus on securitisation activity in the US, we further contribute to the extant literature by providing novel empirical evidence on the European securitisation framework since our securitisation data are mostly originated in European countries. Lastly, unlike Mandel, Morgan, and Wei (2012) and Ashcraft, Vickery, and Goldsmith-Pinkham (2010), we enrich the robustness of the empirical setting by addressing potential endogeneity issues inherent in the analysis and by considering granular information on the credit quality of the institutions originating the mortgages.

Our empirical results are of international relevance and show that both the buffer and the signalling effects are empirically supported by credit enhancements in securitisation transactions by providing evidence of the absence of a real buffer-signalling dichotomy. Therefore, our findings reveal that, in securitisation, the senior-subordinated structure serves not only as a buffer against observable risk but also as a signal of the originator's confidence in the credit quality of the assets sold to securities' investors in the market. Moreover, our main findings are tested against a wide battery of robustness tests which leave our main results qualitatively unaffected.

Our study makes important inferences for policy implications, particularly in light of the recent debate between European lawmakers and national governments on the need to revive the European securitisation markets. Our findings contribute to the post-crisis regulatory response to securitisation, by signalling to policy makers that the mechanism of subordination plays an important role in securitisation. Indeed, we find that the senior-subordinated structure not only affects the degree of protection against the 'first loss exposure' offered to investors, but also serves as a mechanism to convey informed sellers' private information on the securitised pool to uninformed buyers in the market, thus mitigating information frictions endemic to securitisation (Begley and Purnanandam 2016). Therefore, the relevance of our results extends to the current conditions that follow a period of post-crisis regulatory changes, despite this study examines the data generated prior to the post-crisis regulatory response to securitisation. Those regulatory changes, proposed in late September 2015 by the European Parliament and Council, were aimed to create a European framework for simple, transparent, and standardised (STS) securitisation characterised by increased disclosure on securitised assets by originating institutions (European Commission 2015). The objective was to mitigate informational frictions within the set of securitised deals. However, the complexity of securitisation transactions makes disclosure insufficient to fully eliminate information asymmetry (although disclosure certainly remains necessary) and heightens the risk of 'mutual misinformation', in a scenario where informational frictions between the originators and third-party investors are still pervasive in the securitisation market (Schwarcz 2016). Indeed, prior to the financial crisis, the risks associated with complex securitisation transactions and their underlying financial assets, including subprime mortgage loans, were fully disclosed; but that failed to prevent the catastrophic collapse of the securitisation markets (Schwarcz 2008, 2016). We also believe that a better understanding of the mechanism of subordination represents a milestone in the redesign of the securitisation framework to ultimately increase bank lending capacity by freeing up bank capital and thus improving access to credit, of particular relevance for the growth of more financially-constrained SMEs.

The remainder of this paper is organised as follows. Sections 2 discusses the relevant literature, Section 3 describes our data, Section 4 presents our empirical methodology and the results of our empirical analysis testing both the buffer and the signalling hypotheses of subordination, Section 5 reports on the robustness tests and, lastly, in Section 6, we conclude.

2. Related literature and hypotheses

There are two main strands of literature investigating the role played by credit enhancements in securitisation. The first strand provides evidence in favour of the buffer hypothesis according to which greater estimated losses are associated with stronger credit enhancements, if the purpose is to achieve better ratings in the market.[9] This phenomenon would be empirically reflected in a positive relationship between credit enhancements and the pool's delinquency, suggesting that credit enhancements provide securities' investors with an *insurance effect* against potential losses on asset-backed securities (ABS). In this regard, Mandel, Morgan, and Wei (2012) provide evidence consistent with the buffer hypothesis, as they find a significant and positive relationship between the delinquency rate on securitised assets and the credit enhancements provided in the securitisation deal. Similarly, Ashcraft, Vickery, and Goldsmith-Pinkham (2010), by investigating the relationship between credit enhancements and pool performance, find that delinquency on Alt-A and subprime mortgages is positively correlated with the degree of triple-A subordination, thus supporting the buffer hypothesis of credit enhancements in securitisation.

Our discussion of the buffer hypothesis of subordination can be summarised in our first hypothesis (*H1*), which is related to the effect of subordination on the delinquency rate on securitised assets:

H1. If the buffer hypothesis holds true, subordination positively and significantly affects the delinquency rate in securitisation.

The second strand provides evidence in favour of the signalling hypothesis according to which credit enhancements partly solve asymmetric information-related problems that may plague securitisation deals. In this regard, the originator's recourse to signalling devices of unobservable credit quality in securitisation has been investigated in several studies. Downing, Jaffee, and Wallace (2009) provide evidence that the assets sold to the SPV tend to be of lower credit quality ('lemons') than the assets not sold to the special purpose vehicle (SPV), suggesting that the degree of information asymmetry about repayment risk in the government-guaranteed MBS market explains the recourse to signalling devices. Albertazzi et al. (2011) point out the centrality of information asymmetry in the securitisation market and suggest that banks could counter the negative effects of asymmetric information by selling less opaque loans, by retaining a share of the equity tranche of the ABS issued to the SPV ('skin in the game') and by building a sound reputation in the market in order to inspire a certain degree of credibility with final investors. James (2010) provides evidence that originators' risk retention of even modest loss exposure decreases moral hazard and is associated with lower delinquency rates on the securitised assets.[10] Demiroglu and James (2012) find that securitised assets' performance is better when the originator retains 'skin in the game' as a result of affiliation with the deal sponsor or the loan servicer. An et al. (2015) show that subordination levels were driven by non-credit risk factors, including supply and demand factors, deal complexity, issuer incentive and a general time trend. They conclude that, contrary to the traditional view, the subordination level is not just a function of credit risk. Instead, it also reflects the market's need of certain signals regarding the deal structure and is influenced by the balance of power among issuers, credit rating agencies and investors. Kara, Marques-Ibanez, and Ongena (2019) examine the interest rate on corporate ABS backed by syndicated loans and reject the view that securitisation leads to lower credit standards, as banks are likely to keep lower credit quality loans on their balance sheets to signal securitised assets' credit quality to outside investors, thus providing evidence consistent with the signalling argument. In a similar vein, Albertazzi et al. (2015) show that originating banks care about developing a sound reputation stemming from selling high-quality mortgage loans and that the mechanism of risk retention might be interpreted as a commitment device to more carefully monitor loans in a given securitisation deal. Similarly, Erel, Nadauld, and Stulz (2014) investigate the differences among banks in retaining highly-rated tranches of securitisations and conclude that tranche retention may partly serve to send 'a credible signal' of the deal's credit quality to potential investors in the market, i.e. to show that they had 'skin in the game' in the given transaction. Chemla and Hennessy (2014) find that originators may signal positive information via junior retentions or commonly adopt low retentions if the funding value and price informativeness are high. Moreover, Ashcraft, Vickery, and Goldsmith-Pinkham (2010) provide evidence that triple-B subordination is negatively correlated with delinquency on Alt-A deals, which are more opaque and difficult to rate, postulating that the originator's greater subordination serves to signal its confidence in the credit quality of more opaque and difficult-to-rate securitised assets, consistent with the signalling hypothesis. Ashcraft, Gooriah, and Kermani (2019) document the importance of risk retention by informed investors for the performance of securitised assets. Their results suggest that risk retention requirements can have beneficial effects on performance and make uninformed investors more confident about the quality of the underlying assets. However, Kuncl (2019) shows that securitisation self-regulation by risk-retention is inefficient in the boom stage of the business cycle, suggesting that the signalling argument disappears for the subset of securitisation deals issued during a boom since, in the pre-crisis period, many inefficient investments of unknown credit quality were undertaken by originators.

We conjecture that subordination is used as a signalling device of unobservable credit quality of the underlying securitised pool of assets; therefore, our second hypothesis (*H2*) can be formulated as follows:

H2. If the signalling hypothesis holds true, subordination positively and significantly affects the tranche rating variation in securitisation as originators create larger equity tranches in deals with positive information on unobservable dimensions.

Overall, at the heart of all of these studies supporting the signalling argument is the notion that the degree of information asymmetry between originators and investors is the driving force behind the need for recourse to costly signalling mechanisms.[11] This is consistent with the notion that originators are better informed than outside investors about the credit quality of securitised assets. In fact, the originator possesses some kind of private information that places him on a privileged stage with respect to outside investors in a typical securitisation transaction. Therefore, the originator's recourse to signalling devices may in some way mitigate the information asymmetry rooted in securitisation. In this regard, several studies investigate asymmetric information in the context of securitisation. Agarwal, Chang, and Yavas (2012) examine whether loans sold into the secondary mortgage market are of different quality than loans that lenders retain on their balance sheet. They show that banks sold low-default-risk loans into the secondary market and retained higher-default-risk loans in their balance sheets for loans intended to be sold to GSEs (Government-Sponsored Enterprises). In addition, they find support for adverse selection with respect to prepayment risk: securitised loans sold to GSEs entail a higher prepayment risk than loans on lenders' balance-sheets. In contrast, they do not find any conclusive pattern for loans sold in the private subprime market. Jiang, Nelson, and Vytlacil (2014) find that investors are able to reduce information asymmetry by selectively purchasing relatively higher quality loans among the pool of loans offered for sale by exploiting an incremental informational advantage arising between the time of loan origination and the time of loan sale. Adelino, Gerardi, and Hartman-Glaser (2019), using detailed loan-level data on privately securitised mortgages, find a statistically significant and economically meaningful positive relation between ex-post mortgage performance and time to sale. These results both confirm the importance of reducing the private informational gap among parties in the private label securitisation market and provide evidence consistent with a signalling mechanism by which lenders in the market are able to reveal the quality of their loans by delaying trades. Deku, Kara, and Marques-Ibanez (2019a) test whether reputation functions as a self-disciplining mechanism in the MBS market and whether reputable issuers provide higher quality MBS. In this regard, they find that issuers' reputational capital generated from the frequency of MBS issuance predicts future performance, as reputable issuers are likely to issue MBS collateralised by high-quality asset pools characterised by lower delinquency rates. However, in line with Kuncl (2019), these authors find that, during the credit boom period of 2005–2007, the asset pools securitised by reputable issuers were of worse credit quality compared to those securitised by less reputable issuers, possibly due to decreased credit standards. Moreover, the results on the use of the tranching structure as a signalling device confirm the conclusions of Begley and Purnanandam (2016) that the motivation behind security design in residential mortgage-backed securities during the run-up to the subprime mortgage crisis was not only to exploit regulatory incentives, but also to 'mitigate information frictions that were pervasive in this market', as they find that 'deals with a higher level of equity tranche have a significantly lower delinquency rate conditional on observable loan characteristics', thus further supporting the notion that subordination is used as a costly signalling device, especially when there is a larger gap between the sellers' and buyers' information set in securitisation.[12] We depart from these existing studies as we test for the signal theory in securitisation by specifically focusing on the senior-subordinated structure commonly present in MBS deals.

In some ways, the role played by enhancements in the securitisation market could be related to that of collateral in traditional bank lending, in which the originate-to-hold model predominates. The theoretical literature of the 1980s has widely covered the issue of asymmetric information in the credit market. In this respect, the works of Chan and Kanatas (1985) and Besanko and Thakor (1987) postulate that safer borrowers were more willing to pledge collateral as a signalling device in order to distinguish themselves from riskier borrowers. Such works would provide theoretical predictions in line with the signalling hypothesis of credit enhancements in securitisation. However, the empirical study carried out by Berger and Udell (1990) provides evidence against the signalling hypothesis, suggesting that collateral is most often associated with riskier borrowers, riskier loans and riskier banks, which is consistent with the buffer hypothesis of credit enhancements in securitisation. Therefore, the latter work postulates that, when credit risk is observable, the high-risk borrowers tend to pledge collateral.

Our study differs from all of those above as it represents the first attempt to reach conclusive evidence on the buffer-signalling dual role of subordination in securitisation by exploiting not only granular tranche-level and pool delinquency data, but also detailed information on the time-variant credit ratings attributed to each individual tranche comprising a securitisation deal.

3. Data

The data collection process draws on two datasets: SDC Platinum and Global Credit Portal. While SDC Platinum[13] allows us to collect ISIN codes for our sample of RMBS securitisation deals, Global Credit Portal[14] provides us with their relative tearsheets, each representing a single RMBS securitisation deal.[15] Such a dual approach in data collection reflects the way SDC Platinum and Global Credit Portal are designed. On the one hand, SDC Platinum does not possess granular tranche-level information on the degree of subordination, which forms the heart of this empirical study. On the other hand, Global Credit Portal does not allow for multiple and simultaneous tearsheet collection. Therefore, the data collection process has been executed on a one-by-one basis, by manually importing single SDC Platinum's ISIN codes into the Global Credit Portal in order to obtain separate securitisation tearsheets. This approach leads us to the collection of 100 tearsheets containing granular information regarding 100 residential mortgage backed securities (RMBS) securitisation deals originating in nine countries[16] and closing between 2005 and 2007.[17] The result of this process is the creation of a unique and novel proprietary dataset that lays the foundation of our empirical analysis. The latter relies on OLS estimation given the cross-sectional structure of our data. Indeed, each securitisation deal is observed once post-closing and comprises detailed deal- and tranche-level information, both 'historical' (at closing) and 'current' (at data collection date).

We focus our study on RMBS as they were a focal point of the global financial crisis (Griffin, Kruger, and Maturana 2019). RMBS experienced the most severe downgrades (Benmelech and Dlugosz 2010) and, as shown in Piskorski, Seru, and Witkin (2015), a significant degree of misrepresentation of collateral quality exists across private-label RMBS. Moreover, Griffin and Maturana (2016b) show that over 48% of loans backing private-label RMBS exhibit some degree of misreporting and Kruger and Maturana (2020) demonstrate, from RMBS yield spreads and AAA subordination levels, that investors were unaware of such a misreporting behaviour. Additionally, RMBS misreporting and related practices played a central role in credit expansion (Mian and Sufi 2017) and house price growth (Griffin and Maturana 2016a) in the run-up to the global financial crisis. A breakdown of the number of securitisation deals originated in each individual country is provided in Table A1 in the Appendix. We specifically investigate the 2005–2007 period as the latter was characterised by a global credit boom during which banks' lending behaviour was very different from normal times. Therefore, understanding the true mechanism of subordination as a buffer and/or a signalling device in a period characterised by asset misreporting and collusion between banks and rating agencies (and where banks behaved irresponsibly by engaging in excessive risk-taking due to the credit boom) is of crucial and international relevance to enhance the framework of securitisation activity with the objective to offer protection to third-party investors and mitigate information asymmetry in a period of credit market euphoria.

Among the data at our disposal, we can conventionally distinguish four clusters of variables, i.e. deal-, tranche-, credit enhancement-, and delinquency-related information, described in detail later in this section. The degree of segregation of our mentioned clusters is not strict in reality because subordination data are a sub-group of tranche-related information, while the latter is, in turn, a sub-group of deal-level information. Moreover, delinquency-related information is considered a sub-group of the deal-level cluster and represents an excellent proxy for the securitised pool's performance (Ashcraft, Vickery, and Goldsmith-Pinkham 2010; Mandel, Morgan, and Wei 2012).

At the deal-level, we observe the securitised pool's outstanding principal balance, the weighted average loan size (WALS) and the country of origination of securitised assets. As for deal's pricing, we have information on

Total Pool Balance ($)	Tranches ($)		Subordination	Rating
115.273.000	65.057.000	Super Senior A-1	43,56%	AAA
	32.528.000	Senior A-2	15,34%	AAA
	10.843.000	Senior A-3	5,94%	AAA
	2.495.000	Subordinate B-1	3,77%	AA+
	1.508.000	Subordinate B-2	2,47%	AA
	580.000	Subordinate B-3	1,96%	AA-
	638.000	Subordinate B-4	1,41%	A+
	580.000	Subordinate B-5	0,91%	A-
	464.000	Subordinate B-6	0,50%	BBB+
	580.000	Subordinate B-7	0,0%	BBB

Figure 2. Senior-subordinated structure in practice.

Notes: Figure 2 provides a graphical illustration of how subordination allows for risk distribution among different risk classes identified with the tranching structure characterising the deal. For any senior class of securities, the degree of subordination is expressed as a percentage of the deal's outstanding principal balance and refers to the amount of subordination provided by the outstanding principal balances of more junior classes.

the weighted average coupon (WAC). In terms of timing, we observe the deal's closing date, i.e. the ABS issue date, together with the securitisation deal's maturity.

At the tranche-level, we observe the outstanding principal balance date, the principal that has been paid out since the closing date over the course of the transaction. As for tranche's pricing, we have collected data on each tranche-holder remuneration by observing spread values over a common benchmark represented by the three-month European Interbank Offer Rate (or, alternatively, 1M Libor for US transactions). In terms of timing, we observe the tranching structure maturities, i.e. each tranche maturity, in a way similar to the deal's maturity but with a higher degree of data granularity, as our analysis is mainly tranching-focused (Franke, Herrmann, and Weber 2012). Last, in terms of creditworthiness-signalling information, we observe the S&P's credit rating attributed at issuance and the S&P's credit rating in force at data collection. Therefore, we detect the tranche's creditworthiness improvement or deterioration through S&P's credit rating variation over the time frame considered, i.e. closing vs data collection date. Such credit rating variation is crucial to our empirical analysis since it represents our dependent variable in testing the signalling hypothesis of subordination in securitisation.

At the credit enhancement-level, we collect data on the degree of subordination for any given tranche, which is expressed as a percentage of the lower-ranked tranches' amount divided by the pool balance. It is worth remembering that subordination is time-variant with the pace of principal repayments occurring on a sequential and pro-rata basis from the highest-ranked subordination security. In this analysis, subordination refers to the degree in force at data collection, which may be higher than the one at closing, the greater being the principal repaid over the course of the transaction. Since European Securitisation Forum post-issuance reporting standards do not explicitly require original subordination disclosure (ESF 1999), we empirically mitigate time-varying subordination issues by controlling for the tranche's repaid principal amount over the course of the transaction in testing for the signalling hypothesis. Moreover, we mitigate the issue that subordination levels change over time may occur due to mortgages' default or foreclosure by controlling for the deal's pool delinquency rate.

Therefore, the securitisation senior-subordinated structure influences the deal's credit enhancement, as it subordinates junior investors' repayment prospects to senior investors' satisfaction by decreasing the credit risk borne by senior ABS holders. Figure 2 provides a graphical illustration of how subordination allows for risk distribution among different risk classes identified with the tranching structure characterising the deal.

At the delinquency-level, the granularity of our data allows us to gather information on the delinquency rate on the underlying securitised pool of mortgages. Moreover, we are able to disentangle the deal's delinquency based on the number of days the underlying asset has been delinquent that we exploit as a further robustness test. Such delinquency measures distinguish securitised assets that are between 30–59, 60–89 and 90–120 days delinquent, respectively. Delinquency rates proxy the pool's performance and represent our dependent variables in testing the buffer hypothesis of subordination in securitisation (Ashcraft, Vickery, and Goldsmith-Pinkham 2010; Mandel, Morgan, and Wei 2012; Deku, Kara, and Marques-Ibanez 2019a). The dependent and explanatory variables and their descriptive statistics, as well as the correlation matrix, are reported in Tables 1 and 2, respectively. In Table 1 the sample numbers by closing year are also enclosed in square brackets. In Table 2, any pair-wise correlation beyond ±10% is significant at the 10% level at least. In this regard, Table 2 shows that the majority of the pair-wise correlations in regression analysis are within acceptable bounds.

4. Empirical methodology and results

4.1. Buffer hypothesis

We are interested in investigating whether the degree of subordination associated with the design of financial securities in securitisation serves as a buffer against observable risk by providing securities' investors with an insurance effect against assets' delinquency. To test the buffer hypothesis of subordination, we use the pool delinquency rate as our dependent variables, i.e. *delinquency rate*. Table 1 reports that the average pool *delinquency rate* is 3.3% and that *delinquency rate* ranges between a minimum value of 0.00% to a maximum value of 17.68%.

To empirically test the buffer hypothesis, we investigate the relationship between subordination and the rate of the pool delinquency following the approach proposed by Ashcraft, Vickery, and Goldsmith-Pinkham (2010). Our key explanatory variable is *subordination. Subordination* is expressed as a percentage of the pool balance (Ashcraft, Vickery, and Goldsmith-Pinkham 2010) and is computed as the logarithm of the ratio of lower-ranked tranches' amount over the pool balance. Specifically, the degree of subordination is considered the 'attachment point' of a particular rating class, referred to as the fraction of the deal that is junior to that class. The degree of seniority reflects ABS-holders' satisfaction priority and risk profile. While senior classes enjoy a priority claim on securitisation cash flows but receive lower remuneration, junior classes bear the first loss risk on the underlying securitised pool until more senior principal balance is entirely exhausted, while enjoying higher interest rates for bearing higher credit risk. Such risk-return trade-off lies at the heart of the tranching, i.e. the senior-subordinated structure characterising securitisation, allowing for different risk-remuneration distribution among securities' investors. In our study, *delinquency rate* is a continuous variable expressed as a percentage of the outstanding pool balance and computed as the logarithm of the ratio of delinquent assets over the outstanding pool balance. Buffer hypothesis testing is empirically performed by investigating the sign and the significance of the coefficient $\widehat{\beta_1}$ in Equation (1), which reflects the relationship between subordination and the pool's delinquency. If $\widehat{\beta_1}$ is non-statistically and significantly different from zero, then the delinquency rate of securitised assets would not be affected by the senior-subordinated structure. We assume that a positive and statistically significant coefficient for subordination $\widehat{\beta_1} > 0$ would validate the buffer hypothesis. Theoretically, validating the buffer hypothesis would imply greater subordination to serve as a protection mechanism against observable and quantifiable risk. Empirically, our strategy investigates if greater subordination is correlated with higher pool delinquency. Investigating the relationship between subordination and pool delinquency allows us to understand the potential buffer role played by subordination itself.

Following Ashcraft, Vickery, and Goldsmith-Pinkham (2010), our OLS baseline regression model for the buffer hypothesis of subordination takes the following form:

$$\begin{aligned} \textit{Delinquency Rate}_i = \beta_0 &+ \sum_{ni} \beta_{1,n}(\textit{Subordination})_{ni} + \sum_{ji} \beta_{2,j}(\textit{Deal characteristics})_{ji} \\ &+ \sum_{ni} \beta_{3,n}(\textit{Tranche characteristics})_{ni} + \textit{Year}_t + \textit{Geography}_k + \textit{Tranche}_n + \varepsilon_i \end{aligned} \tag{1}$$

Table 1. Descriptive statistics (values expressed in euro).

Variable	N	Mean	Std. Dev.	Min	Max
Dependent Variables					
ΔRating	309	− 4	4.5	− 17	3
[2005; 2006; 2007]	[115; 151; 43]	[−2.4; −5.1; −7.0]	[3.38; 4.44; 5.77]	[−15; −15; −17]	[3; 3; 0]
Rating variation	309	0.78	0.41	0	1
[2005; 2006; 2007]	[115; 151; 43]	[0.71; 0.87; 0.72]	[0.45; 0.34; 0.45]	[0; 0; 0]	[1; 1; 1]
Rating variation_012	309	0.86	0.52	0	2
[2005; 2006; 2007]	[115; 151; 43]	[0.83; 0.93; 0.72]	[0.62; 0.44; 0.45]	[0; 0; 0]	[2; 2; 1]
Delinquency Rate	401	3,28%	4,49%	0.00%	17.68%
[2005; 2006; 2007]	[150; 200; 51]	[3.24%; 3.29%; 3.36%]	[4.40%; 4.93%; 2.75%]	[0.00%; 0.00%; 0.00%]	[13.73%; 17.68%; 7.05%]
Delinquency Rate 30–59	392	2.19%	3.10%	0.00%	10.70%
[2005; 2006; 2007]	[147; 194; 51]	[1.91%; 2.46%; 1.99%]	[2.43%; 3.73%; 1.91%]	[0.00%; 0.00%; 0.00%]	[7.13%; 10.70%; 4.42%]
Delinquency Rate 60–89	387	0,69%	1,05%	0,00%	4,52%
[2005; 2006; 2007]	[147; 189; 51]	[0.66%; 0.55%; 1.26%]	[1.02%; 0.91%; 1.37%]	[0.00%; 0.00%; 0.00%]	[3.66%; 3.73%; 4.52%]
Delinquency Rate 90–120	385	0,49%	0,94%	0,00%	3,65%
[2005; 2006; 2007]	[147; 194; 44]	[0.72%; 0.39%; 0.13%]	[1.07%; 0.89%; 0.24%]	[0.00%; 0.00%; 0.00%]	[3.07%; 3.65%; 0.93%]
Tranche-level Variables					
Subordination	352	6.84%	10.13%	0.00%	75.16%
[2005; 2006; 2007]	[137; 169; 46]	[6.89%; 7.58%; 3.98%]	[11.07%; 10.19%; 5.60%]	[0.00%; 0.00%; 0.00%]	[75.16%; 58.07%; 18.27%]
Tranche outstanding balance	399	96,800,000	222,000,000	0	1,590,000,000
[2005; 2006; 2007]	[150; 198; 51]	[72,000,000; 107,000,000; 131,000,000]	[160,000,000; 235,000,000; 307,000,000]	[0; 0; 0]	[781,000,000; 1,460,000,000; 1,590,000,000]
Original tranche rating	375	15.77	4.19	3	20
[2005; 2006; 2007]	[145; 183; 47]	[15.66; 15.87; 15.68]	[4.20; 4.17; 4.33]	[3; 3; 3]	[20; 20; 20]
Current tranche rating	309	10.87	5.55	1	20
[2005; 2006; 2007]	[115; 151; 43]	[12.48; 10.39; 8.25]	[4.49; 5.66; 6.45]	[3; 1; 1]	[20; 20; 20]
Tranche Spread	404	0.55%	0.77%	0.00%	4.00%
[2005; 2006; 2007]	[150; 200; 51]	[0.60%; 0.51%; 0.54%]	[0.81%; 0.70%; 0.85%]	[0.00%; 0.00%; 0.00%]	[4.00%; 3.90%; 4.00%]
Tranche's repaid amount	401	102,000,000	225,000,000	0	1,540,000,000
[2005; 2006; 2007]	[150; 200; 51]	[112,000,000; 99,400,000; 86,200,000]	[247,000,000; 214,000,000; 202,000,000]	[0; 0; 0]	[1,540,000,000; 1,380,000,000; 1,100,000,000]
Pool-level Variables					
Pool's outstanding balance	401	529,000,000	424,000,000	12,500,000	1,870,000,000
[2005; 2006; 2007]	[150; 200; 51]	[365,000,000; 593,000,000; 765,000,000]	[251,000,000; 395,000,000; 688,000,000]	[12,500,000; 104,000,000; 79,700,000]	[8,440,00,000; 1,560,000,000; 1,870,000,000]
Weighted average coupon	401	3,75%	1,37%	1,67%	7,80%
[2005; 2006; 2007]	[150; 200; 51]	[3.77%; 3.63%; 4.15%]	[1.55%; 1.20%; 1.42%]	[1.74%; 1.67%; 2.39%]	[7.80%; 5.97%; 5.83%]
Weighted average loan size	341	101,935.40	41,782.82	12,434	195,057
[2005; 2006; 2007]	[150; 157; 34]	[82,794.47; 112,627.20; 137,010.20]	[35,871.14; 38,963.79; 39,034.49]	[12,434; 39,164; 40,275]	[172.,792; 195,057; 193,384]

Notes: Data are manually collected from Standard & Poor's Global Credit Portal database. The sample numbers by closing year are enclosed in in square brackets.

where the subscript i indicates the securitisation deal, the subscript j indicates the given characteristic of the securitisation deal, while the subscript n indicates the individual tranche, i.e. the tranching structure comprising the given deal; $Year_t$ represents closing year fixed effects; $Geography_k$ reflects the European or US nature of the transaction; and $Tranche_n$ indicate tranche maturity fixed effects.

Our results, reported in Table 3, are supportive of the buffer hypothesis stating that subordination serves as a buffer against the greater observable risk that is intrinsic to relatively risky borrowers. In this regard, Table 3 shows that the relationship between subordination and pool delinquency is positive and statistically significant

Table 2. Correlation matrix.

	Delinquency rate	Δ*Rating*	Subordination	Pool outstanding principal balance	Tranche outstanding principal balance	Weighted average coupon	Weighted average loan size	Tranche repaid amount	Tranche Spread	Original tranche rating	Current tranche rating
Delinquency rate	1										
Δ*Rating*	−0.358**	1									
Subordination	0.309**	−0.044	1								
Pool outstanding principal balance	−0.684**	0.154**	−0.268**	1							
Tranche outstanding principal balance	−0.277**	0.271**	0.327**	0.244**	1						
Weighted average coupon	0.362**	−0.258**	0.099	−0.309**	−0.195**	1					
Weighted average loan size	−0.070	−0.088	−0.061	0.314**	0.047	−0.062	1				
Tranche repaid amount	−0.022	−0.011	0.177**	−0.078	−0.183**	−0.128*	−0.192**	1			
Tranche Spread	0.069	0.064	−0.295**	−0.117*	0.027	−0.003	0.073	−0.134**	1		
Original tranche rating	0.066	−0.186**	0.474**	−0.006	−0.075	0.070	−0.048	0.378**	−0.763**	1	
Current tranche rating	−0.277**	0.689**	0.400**	0.142*	0.509**	−0.138*	−0.104	0.241**	−0.492**	0.584**	1

Notes: Data are manually collected from Standard & Poor's Global Credit Portal database. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, respectively.

Table 3. Baseline model for the buffer hypothesis of subordination.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Subordination	0.235***	0.164***	0.140***	0.111***	0.089***	0.085***	0.077***	0.081***
	(0.048)	(0.034)	(0.037)	(0.039)	(0.029)	(0.031)	(0.022)	(0.021)
Pool outstanding principal balance					−0.019***	−0.019***	−0.023***	−0.023***
					(0.004)	(0.004)	(0.003)	(0.003)
Tranche outstanding principal balance					0.001	0.001	0.002*	0.002
					(0.002)	(0.002)	(0.001)	(0.001)
Weighted average coupon					0.005	0.005	0.019	0.020*
					(0.011)	(0.011)	(0.012)	(0.011)
Weighted average loan size					0.008*	0.009*	0.011**	0.008
					(0.005)	(0.005)	(0.004)	(0.005)
Tranche repaid amount					0.000	0.000	−0.000	−0.000
					(0.000)	(0.000)	(0.000)	(0.000)
Tranche Spread					0.687**	0.695**	0.454*	0.490**
					(0.282)	(0.312)	(0.231)	(0.230)
Current tranche rating	−0.004***	−0.002***	−0.002***	−0.001*	−0.001	−0.001	−0.001***	−0.001***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Observations	298	298	298	298	256	256	256	256
R^2	0.32	0.50	0.54	0.61	0.56	0.54	0.75	0.76
Closing Year FE	YES	NO	NO	YES	YES	NO	NO	YES
Geographic FE	NO	YES	NO	YES	NO	YES	NO	YES
Tranche Maturity FE	NO	NO	YES	YES	NO	NO	YES	YES

Notes: The table presents the results of OLS regression analysis for the dependent variable *delinquency rate* which refers to the percentage of securitised assets which are delinquent. Columns (1) to (4) are a reduced form of the full model of Equation (1). Closing year, geographic and tranche maturity fixed effects are incorporated in regression analysis, where indicated. Robust errors, reported in parentheses, are clustered at the securitisation deal level. $*** p < 0.01$, $** p < 0.05$, $* p < 0.1$, respectively.

at the 1% level, suggesting that greater subordination amounts are associated with higher delinquency rates on securitised assets (Ashcraft, Vickery, and Goldsmith-Pinkham 2010; Mandel, Morgan, and Wei 2012). The latter result of subordination as a buffer against observable risk is supported by the existing studies of Ashcraft, Vickery, and Goldsmith-Pinkham (2010) and Mandel, Morgan, and Wei (2012) that provide evidence of a positive relationship between credit enhancements and the delinquency on securitised assets, consistent with the buffer hypothesis of credit enhancement provisioning in securitisation. Confirmatory evidence is provided by Figure 3 showing the predicted outcomes of *delinquency rate* at different percentiles of *subordination:* when moving from the 10th percentile to the 90th percentile of *subordination* distribution, the delinquency rate increases, on average, from 1.5% to 3%, respectively.[18] Therefore, greater subordination is likely to be associated with a stronger insurance effect for investors against potential losses on the acquired asset-backed securities, which is in line with that stream of the literature stating that credit enhancements in securitisation would act as a buffer against demonstrably risky borrowers. Therefore, observable risk, computed ex ante, would determine the senior-subordinated structure of a given securitisation deal in order to provide an insurance effect to securities' investors.

Moreover, we set up an identification strategy by testing whether the effect of subordination as a protection mechanism increases with the degree of the tranche's seniority. This hypothesis is formed because the protection derived from the senior-subordinated structure of a given securitisation deal is expected to increase with the degree of the tranche's seniority, as subordination serves as a protection mechanism for more senior ABS holders. To perform this analysis, we interact the degree of subordination with three binary variables, expression of the credit quality of a given securitised tranche, i.e. *junior*, *mezzanine* and *senior*. Tranche classification according to the underlying observable risk is possible due to the granularity of our data, which allows us to distinguish the intrinsic risk in each tranche according to the equivalent rating attributed by S&P. In this regard, firstly, the binary variable *junior* takes the value of 1 every time we observe a tranche credit rating belonging to the 'speculative

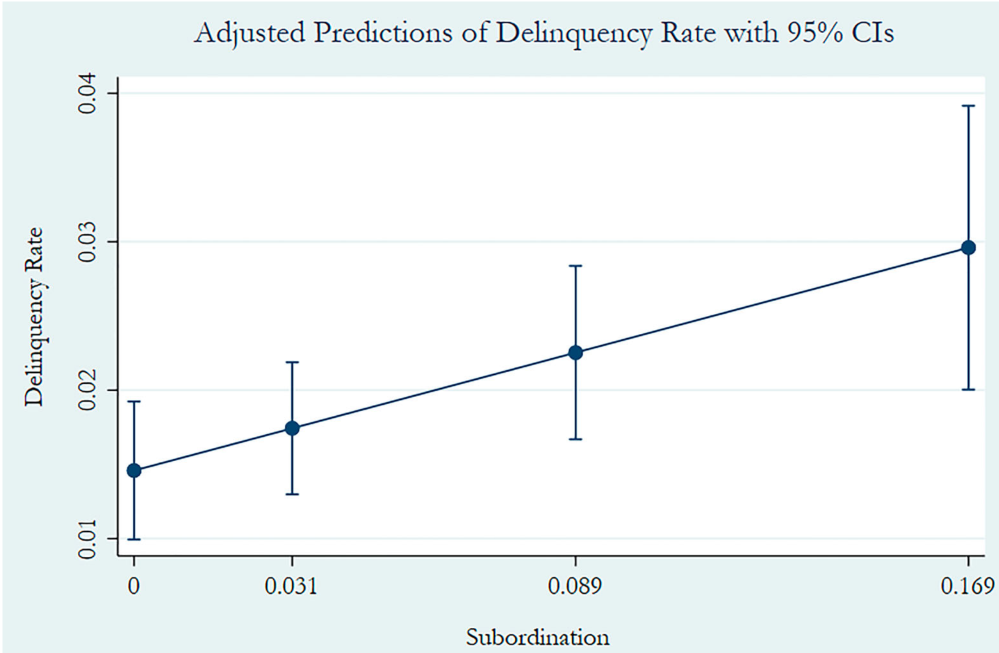

Figure 3. Predicted outcomes of *Delinquency Rate* at percentiles of *Subordination*.
Notes: On the x-axis are reported the, 25th, 50th, 75th, and 90th percentiles of *Subordination* distribution.

grade' category according to S&P's classification, i.e. equal or below BB, and 0 otherwise. Secondly, the binary variable *mezzanine* is equal to 1 every time the rating associated with a given tranche belongs to the 'investment grade' category but falls below the A rating class according to S&P's classification, i.e. rating between BB+ and BBB+, and 0 otherwise. Lastly, the binary variable *senior* is equal to 1 every time the given tranche credit rating belongs to the 'investment grade' category and falls in the A rating class according to S&P's classification, i.e. equal or above A-, and 0 otherwise. This process leads us to construct three different interaction terms derived from interacting *subordination* with each of these three binary variables reflecting the risk intrinsic in each securitised tranche, i.e. *subordination*junior*, *subordination*mezzanine*, and *subordination*senior*, respectively. Therefore, Equation (2) simultaneously includes these latter three interaction terms, as well as their relative lower-order terms, i.e. *junior*, *mezzanine* and *senior*, respectively.

Our OLS regression model for the buffer hypothesis of subordination according to tranche seniority takes the following form:

$$\begin{aligned} DelinquencyRate_i = \beta_0 &+ \sum_{ni} \beta_{1,n}(Subordination * Senior)_{ni} + \sum_{ni} \beta_{1,n}(Subordination * Mezzanine)_{ni} \\ &+ \sum_{ni} \beta_{1,n}(Subordination * Junior)_{ni} + \sum_{ji} \beta_{2,j}(Deal\ characteristics)_{ji} \\ &+ \sum_{ni} \beta_{3,n}(Tranche\ characteristics)_{ni} + Year_t + Geography_k + Tranche_n + \varepsilon_i \end{aligned} \quad (2)$$

where the subscript i indicates the securitisation deal, the subscript j indicates the given characteristic of the securitisation deal, while the subscript n indicates the individual tranche, i.e. the tranching structure comprising the given deal; $Year_t$ represents closing year fixed effects; $Geography_k$ reflects the European or US nature of the transaction; and $Tranche_n$ indicate tranche maturity fixed effects.

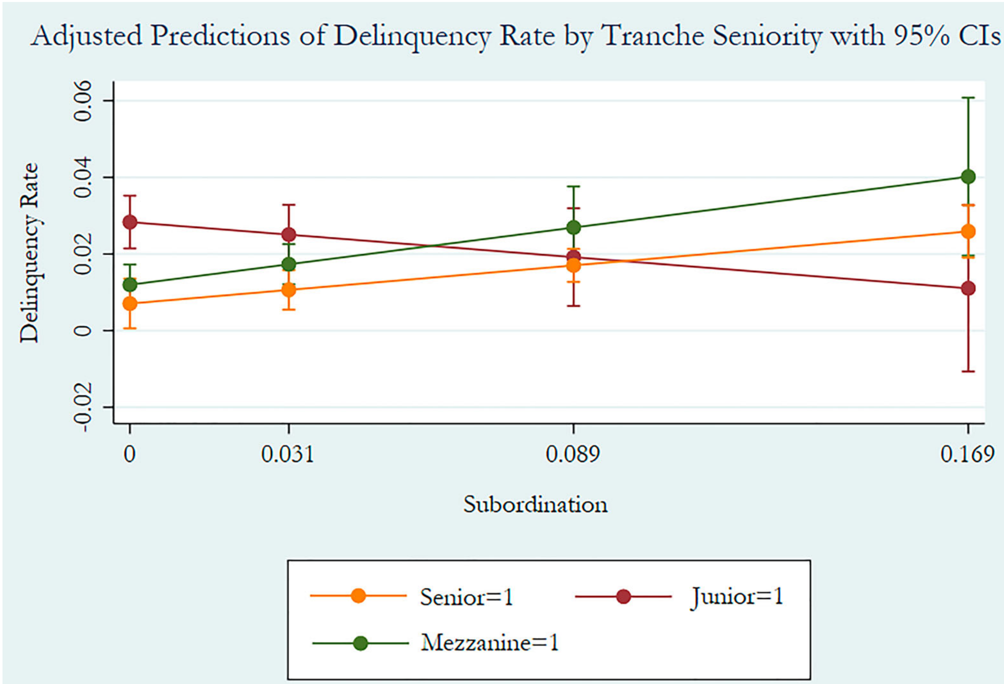

Figure 4. Predicted outcomes of *Delinquency Rate* by tranche seniority at percentiles of *Subordination*.
Notes: On the x-axis are reported the, 25th, 50th, 75th, and 90th percentiles of *Subordination* distribution.

Our results are reported in Table 4. Interestingly and in line with our expectations, our findings suggest that the effect of subordination on delinquency rate is stronger the more we go up in the tranche seniority structure of the deal, thus corroborating the notion that the insurance effect provided by subordination is more pronounced for more senior ABS investors. This result is empirically achieved by investigating and comparing the sign and the significance of the interaction terms *subordination∗senior* and *subordination∗mezzanine* in Equation (2). Therefore, greater subordination is likely to be associated with a stronger insurance effect for more senior investors against potential losses on the acquired asset-backed securities (Ashcraft, Vickery, and Goldsmith-Pinkham 2010; Deku, Kara, and Marques-Ibanez 2019a). This finding is consistent with Ashcraft, Vickery, and Goldsmith-Pinkham (2010) and Deku, Kara, and Marques-Ibanez (2019a) that highlight that greater subordination is associated with a lower likelihood that senior securities absorb credit losses, in a waterfall structure of cash flow/loss distribution according to which mortgage principal payments are first paid to senior tranches, while realised mortgage losses are allocated from the bottom-up, i.e. from the junior tranche to the senior-most tranche. Graphical confirmatory evidence of the predictive margins of the delinquency rate according to tranche seniority for the different percentiles of *subordination* is provided in Figure 4 showing that, on average, the predicted *delinquency rate* is increasing in tranche seniority, in line with our theoretical expectations and empirical findings. Indeed, at the 90th percentile of *subordination* distribution, the predicted delinquency rate is, on average, 2.6% and 4% for senior and mezzanine tranches respectively, with respect to 1.1% for junior tranches.

4.2. Signalling hypothesis

We are also interested in investigating whether security design in the form of the senior-subordinated structure in securitisation narrows originator-investor information asymmetries by acting as a signalling device of unobservable credit quality to outside investors in the market. To test the signalling hypothesis of subordination, we

Table 4. Model for the buffer hypothesis of subordination according to tranche riskiness.

	(1)	(2)	(3)	(4)
VARIABLES	OLS	OLS	OLS	OLS
Subordination	−0.103	−0.114	0.009	0.019
	(0.062)	(0.066)	(0.041)	(0.041)
Subordination∗senior	0.214∗∗∗	0.221∗∗∗	0.077∗∗	0.072∗
	(0.068)	(0.071)	(0.040)	(0.040)
Subordination∗mezzanine	0.270∗∗∗	0.288∗∗∗	0.161∗∗∗	0.129∗∗
	(0.099)	(0.097)	(0.060)	(0.058)
Mezzanine	−0.010	−0.012	−0.001	0.001
	(0.007)	(0.008)	(0.005)	(0.005)
Senior	−0.013	−0.016	0.000	0.003
	(0.011)	(0.011)	(0.007)	(0.007)
Pool outstanding principal balance	−0.020∗∗∗	−0.020∗∗∗	−0.024∗∗∗	−0.024∗∗∗
	(0.004)	(0.004)	(0.004)	(0.004)
Tranche outstanding principal balance	0.001	0.002	0.002∗	0.002∗
	(0.002)	(0.002)	(0.001)	(0.001)
Weighted average coupon	0.005	0.005	0.019	0.020∗
	(0.011)	(0.011)	(0.012)	(0.011)
Weighted average loan size	0.009∗∗	0.010∗∗	0.011∗∗	0.008
	(0.004)	(0.004)	(0.004)	(0.005)
Tranche repaid amount	0.000	0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Tranche Spread	0.291	0.275	0.358	0.414∗
	(0.273)	(0.298)	(0.241)	(0.241)
Current tranche rating	−0.001	−0.000	−0.001∗∗	−0.002∗∗
	(0.001)	(0.001)	(0.001)	(0.001)
Observations	256	256	256	256
R^2	0.60	0.58	0.75	0.76
Closing Year FE	YES	NO	NO	YES
Geographic FE	NO	YES	NO	YES
Tranche Maturity FE	NO	NO	YES	YES

Notes: The table presents the results of OLS regression analysis for the dependent variable *delinquency rate* which refers to the percentage of securitised assets which are delinquent. Subordination is interacted with the dummies *senior*, i.e. *subordination∗senior, mezzanine*, i.e. *subordination∗mezzanine*, and *junior*, i.e. *subordination∗junior* (the latter out of regressions to avoid collinearity), to capture the differential effect of subordination on the delinquency rate based on tranche riskiness. Closing year, geographic and tranche maturity fixed effects are incorporated in regression analysis, where indicated. Robust errors, reported in parentheses, are clustered at the securitisation deal level. ∗∗∗ $p < 0.01$, ∗∗ $p < 0.05$, ∗ $p < 0.1$, respectively.

performed OLS regressions in which the dependent variable $\Delta Rating$ is a categorical variable different from zero each time S&P's rating at issuance is different from S&P's rating at data collection.[19] The intuition behind using credit ratings as our dependent variable to test the signalling hypothesis stems from the fact that issuers can use good ratings to signal low-risk and high-quality governance, thereby reducing their cost of financing (Fabozzi and Vink 2015; Greenbaum, Thakor, and Boot 2019). Banks may securitise apparently better loans based on publicly observable characteristics in order to signal credit quality while still exploiting their information advantage over outsiders. In fact, the signalling argument relies on the fact that outsiders could only roughly assess the credit quality of the securitised assets through observable indicators such as subordination. Hence, banks would have an incentive to use subordination as a signal of the good credit quality of the securitised pool, as this could be inferred by outsiders from the securitised assets' observable characteristics at the time of securitisation (Kara, Marques-Ibanez, and Ongena 2019).

Our OLS baseline regression model for the signalling hypothesis of subordination takes the following form:

$$\Delta Rating_n = \beta_0 + \beta_{1,n}(Subordination)_n + \sum_{ji} \beta_{2,j}(Dealcharacteristics)_{ji} + \sum_{ni} \beta_{3,n}(Tranchecharacteristics)_{ni} + Year_t + Geography_k + Tranche_n + \varepsilon_n \quad (3)$$

where the subscript i indicates the securitisation deal, the subscript j indicates the given characteristic of the securitisation deal, while the subscript n indicates the individual tranche, i.e. the tranching structure comprising the given deal; $Year_t$ represents closing year fixed effects; $Geography_k$ reflects the European or US nature of the transaction; and $Tranche_n$ indicate tranche maturity fixed effects.

In this respect, $\Delta Rating$ assumes values different from 0 each time S&P decides to adjust (upwards or downwards) the rating assigned at closing for any given tranche and is computed in notches. $\Delta Rating$ takes positive integers in the case of S&P's upwards adjustments of the tranche's rating class attributed at the beginning of the transaction, presumably due to an improvement in the tranche's creditworthiness. To the contrary, $\Delta Rating$ is a negative integer when S&P downgrades the initial rating class, presumably due to credit quality deterioration since closing. Consequently, $\Delta Rating$ takes the value of 0 when S&P decides neither to upgrade nor to downgrade the original rating associated with a given securitised tranche, i.e. every time S&P confirms the rating attributed at closing without amending it. Signalling hypothesis testing is empirically performed by investigating the sign and the significance of the coefficient $\widehat{\beta_1}$ in Equation (3), which reflects the relationship between subordination and the tranche's rating adjustment over time. If $\widehat{\beta_1}$ is non-statistically and significantly different from zero, then rating corrections would not be affected by the senior-subordinated structure. In contrast, positive and statistically significant coefficients for subordination, i.e. $\widehat{\beta_1} > 0$, would indicate that greater subordination is associated with positive rating variations, while $\widehat{\beta_1} < 0$ would indicate that subordination is associated with negative rating adjustments. While the tranche ratings at closing are computed ex ante by the engaged rating agency on the basis of an estimated loss function affecting securities' investors' repayment prospects (Ashcraft and Schuermann 2008), rating corrections mirror variations between closing vs up-to-date tranche credit ratings. Theoretically, validating the signalling hypothesis would imply greater subordination to reflect the originator's effort to signal its confidence in the pool's credit quality to outside investors in the market. Empirically, our strategy investigates if greater subordination is correlated with positive rating adjustments at the tranche level. As for the underlying economic interpretation, we argue that greater asset opaqueness is associated with rating agencies' more conservative attitudes at issuance. In this scenario, the originator strives to demonstrate its confidence in the securitised assets' creditworthiness by pledging greater subordination in favour of securities' investors. The tranche positive rating variation over time would therefore reflect the subsequent well-performing attitude of securitised assets, pushing rating agencies to adjust upwards their previous evaluations. To some extent, $\widehat{\beta_1} > 0$ would be consistent with Ashcraft, Vickery, and Goldsmith-Pinkham (2010), who provide evidence that the originator's greater subordination signals its confidence in the credit quality of more opaque and difficult-to-rate securitised assets, which is supportive of the signalling hypothesis in securitisation. Moreover, Table 1, by reporting that the average $\Delta Rating$ is -4, ranging from a minimum value of -17 to a maximum of $+3$, shows that rating downgrades are disproportionately greater in magnitude than upgrades, suggesting a prudential attitude of rating agencies over the course of the securitisation transaction. Since tranche ratings at collection date refer to the post-crisis period, we argue that such a prudential attitude could possibly reflect not only the bad performance of downgraded assets but also a downwards revision of ratings due to excessive optimism on the part of credit agencies in the years preceding the crisis or better post-crisis monitoring activity following the consequences of the crisis itself.

Our results, reported in Table 5, are consistent with the notion that subordination may also play a signalling role (Ashcraft, Vickery, and Goldsmith-Pinkham 2010; Mandel, Morgan, and Wei 2012). The result that subordination can act as a signalling device of unobservable credit quality is supported by the existing studies of Ashcraft, Vickery, and Goldsmith-Pinkham (2010) and Mandel, Morgan, and Wei (2012) that confirm the signalling hypothesis of credit enhancement provisioning in securitisation. On the one hand, Ashcraft, Vickery, and Goldsmith-Pinkham (2010) show that BBB subordination is negatively associated with mortgage performance on Alt-A deals (considered as more opaque and hard-to-rate), consistent with the signalling hypothesis according to which the issuer of an opaque security submits to a high degree of subordination to signal its confidence in the quality of the assets it is selling. On the other hand, Mandel, Morgan, and Wei (2012) find that BHC stock prices reacted favourably to high enhancement provisioning among banks with better-performing (lower-delinquency) securitisations, consistent with the signalling argument. According to the signalling hypothesis, subordination would therefore serve as a market signal of the originator's confidence in the credit quality of

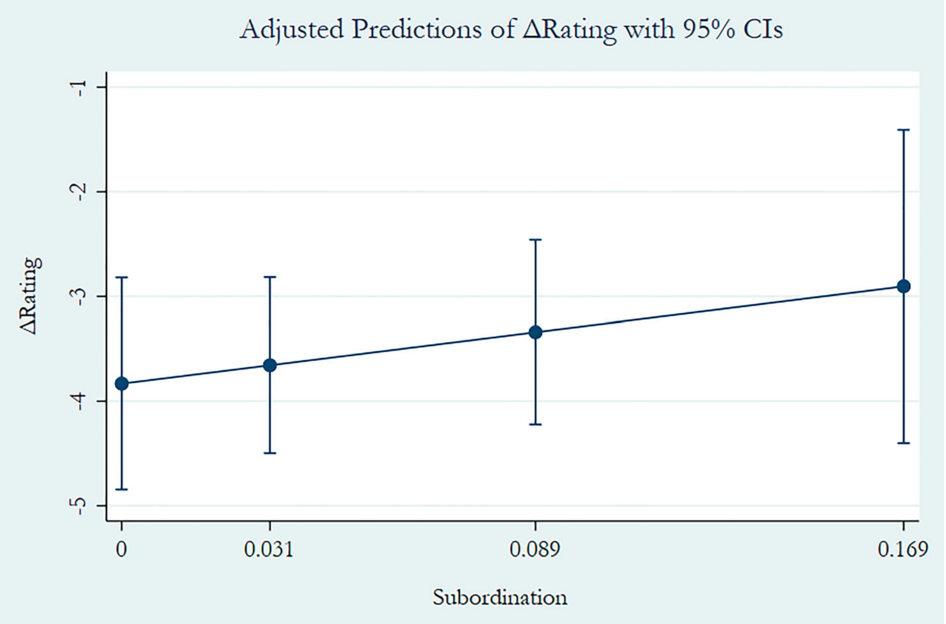

Figure 5. Predicted outcomes of Δ *Rating* at percentiles of *Subordination*.
Notes: On the x-axis are reported the, 25th, 50th, 75th, and 90th percentiles of *Subordination* distribution.

securitised assets. In this regard, our results reported in Table 5 show that the relationship between subordination and the tranche-rating evolution over time is likely to support such a hypothesis. In fact, such a relationship is positive and statistically significant at the 1% level, suggesting that greater subordination amounts are associated with an increased tendency by the rating agency to perform upward variations of the credit ratings of asset-backed securities over time. Confirmatory evidence is provided by Figure 5 showing the predicted outcomes of Δ*Rating* at different percentiles of *subordination:* when moving from the 10th percentile to the 90th percentile of *subordination* distribution, Δ*Rating* increases, on average, from −3.8 to −2.9 (+24.2%), respectively.[20] Therefore, ratings tend to be more conservative at issuance when assets are relatively opaque and difficult to rate. In this respect, the originator's effort to signal its confidence by pledging a higher level of subordination is reflected in the subsequent well-performing attitude of such assets, pushing rating agencies to adjust upwards their previous evaluations.

Therefore, the overall empirical findings of this study are likely to suggest that subordination plays a buffer-signalling dual role in securitisation and are relevant from a policy perspective in light of the recent agreement reached by European lawmakers with national governments to revive the European securitisation markets and to create a Capital Markets Union. Even if the resulting policy implications are not directly and explicitly linked to our results, the latter can still prove to be valuable not only to adequately protect investors consistent with their risk profiles but also to mitigate information asymmetries between originators and investors that are still pervasive in the securitisation market.

4.3. Control variables

In all the aforementioned regressions, to isolate the effect of *subordination* on *delinquency rate* and Δ*Rating*, we control for a large number of possible confounding factors related to the characteristics of the given securitisation deal and the peculiarities of its tranching structure. With regard to the deal's characteristics, first we include geographic fixed effects that allow to distinguish the EU and the US origination of the securitised assets to control for the unobserved geographical characteristics of the European and the US local market and credit policies. In a similar vein, we include fixed effects related to the transaction's closing year, spanning 2005–2007,

Table 5. Baseline model for the signalling hypothesis of subordination.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
Subordination	13.353**	9.672*	15.328***	8.500*	5.496*	5.674*	8.704**	8.600***
	(6.058)	(5.709)	(5.485)	(4.445)	(5.609)	(5.494)	(4.151)	(3.996)
Pool outstanding principal balance					0.242	0.033	−0.806	−0.739
					(1.018)	(1.048)	(0.820)	(0.812)
Tranche outstanding principal balance					−0.453	−0.458	−0.186	−0.195
					(0.355)	(0.372)	(0.338)	(0.331)
Weighted average coupon					−0.009	0.218	1.614	1.660
					(1.134)	(1.168)	(1.287)	(1.262)
Weighted average loan size					0.051	−0.356	−0.110	−0.031
					(1.028)	(1.093)	(0.864)	(0.887)
Tranche repaid amount					0.034	0.053	−0.030	−0.028
					(0.051)	(0.056)	(0.051)	(0.050)
Tranche Spread					−29.131	−31.995	−0.948	−1.402
					(40.772)	(42.277)	(42.161)	(42.659)
Original tranche rating	−0.370***	−0.323***	−0.385***	−0.280***	−0.186	−0.232	−0.209	−0.205
	(0.110)	(0.099)	(0.108)	(0.089)	(0.164)	(0.173)	(0.162)	(0.148)
Delinquency rate	−49.747***	−9.639	−30.633**	−9.539	−18.769	−19.409	−50.677**	−51.360**
	(11.395)	(11.509)	(11.956)	(11.107)	(25.500)	(27.417)	(19.390)	(20.310)
Observations	298	298	298	298	256	256	256	256
R^2	0.30	0.36	0.40	0.49	0.11	0.07	0.33	0.33
Closing Year FE	YES	NO	NO	YES	YES	NO	NO	YES
Geographic FE	NO	YES	NO	YES	NO	YES	NO	YES
Tranche Maturity FE	NO	NO	YES	YES	NO	NO	YES	YES

Notes: The table presents the results of OLS regression analysis for the dependent variable Δ*Rating* which is a categorical variable different from zero each time S&P's *original tranche rating* at issuance is different from S&P's *current tranche rating* at data collection. Columns (1) to (4) are a reduced form of the full model of Equation (3). Closing year, geographic and tranche maturity fixed effects are incorporated in regression analysis, where indicated. Robust errors, reported in parentheses, are clustered at the securitisation deal level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, respectively.

to control for the temporal variation in our dependent variables for reasons that may not be adequately captured by the explanatory variables in our OLS model that could eventually lead to omitted variable issues. In addition, we account for the *weighted average loan size* and the *pool outstanding balance*. *Pool outstanding balance* measures the transaction's magnitude, which may affect, among other factors, the deal's subordination structure, while *weighted average loan size* is likely to mitigate risk heterogeneity across deals, as larger loans are generally associated with more accurate lenders' screening efforts. Lastly, we also control for the *weighted average coupon* in force as of data collection, as higher securitisation return profiles bear greater credit risk and, in turn, higher expected delinquency rates on securitised assets. Thus, controlling for such factors leads to reach a higher degree of homogeneity in a transaction's volume and risk, which are likely to affect the pool delinquency rate.

As our empirical analysis is tranche-focused, we collect several data on the tranche's peculiarities. We first control for fixed effects related to the tranche maturity in order to control for the potential maturity-dependent tranches' heterogeneity, which may affect the pace of principal repayments and the timing of delinquency. All our models control for tranche riskiness by including the S&P's tranche rating attributed to the given tranche either at closing date, i.e. *original tranche rating* or at data collection, i.e. *current tranche rating*. Due to the time variation of subordination with principal repayments, we control for the *tranche repaid amount* to mitigate the absence of subordination information at closing. As with *pool outstanding balance*, we observe the t*ranche outstanding balance*, leading to homogeneity in our tranche-centred empirical model. As with the *weighted average coupon*, we control for the *tranche spread* over a common benchmark typically represented by the 3M Euribor or 1M Libor for US securitisation transactions, i.e. *tranche spread*, as higher spreads are more likely to be associated with greater credit risk and delinquencies.[21]

5. Robustness tests

To confirm the validity of our empirical results on the buffer-signalling dual role played by the senior-subordinated structure insecuritisation, we perform a wide battery of robustness tests that leave our main results qualitatively unaffected.

5.1. Alternative estimation methods for the signalling hypothesis of subordination

5.1.1. LPM, logit and multinomial logit models

To provide additional confirmatory evidence of the signalling hypothesis of subordination we implement linear probability models (LPM), logit, and multinomial logit models to test the robustness of our previous results on subordination acting as a signal of unobservable credit quality to investors that materialises in a positive effect of subordination on the tranche rating evolution. On the one hand, we run our baseline model for the signalling hypothesis by using LPM and logit models. To this purpose, we build the binary variable *rating variation* which takes the value of 1 each time the given tranche rating varies and 0 otherwise, independent of upwards or downwards rating variation. Results of LPM and logit models are reported in Table 6. On the other hand, we run our baseline model for the signalling hypothesis by using multinomial logit models in which we are able to disentangle the effect of subordination on tranche rating variation across upgrades and downgrades. To this purpose, we build the discrete variable *rating variation_012* which takes the value of 1 in case of downgrades, the value of 2 in the happening of upgrades, and 0 otherwise. Results of multinomial logit models are reported in Table 7. Interestingly, both LPM and logit models' results indicate that greater subordination reduces rating agencies' propensity to adjust tranche ratings. Nonetheless, multinomial logit models' results suggest that greater subordination decreases rating agencies' propensity to perform downward rating variations. Figure 6, showing the predicted outcomes of rating downgrade at different percentiles of *subordination,* indicates that, on average,

Table 6. Robustness: LPM and Llogit models for the signalling hypothesis of subordination.

	(1)	(2)	(3)	(4)
VARIABLES	LPM	LPM	Logit	Logit
Subordination	−0.754*	−1.079**	−6.276*	−9.591***
	(0.545)	(0.594)	(4.572)	(3.940)
Pool outstanding principal balance		0.044		0.584
		(0.069)		(0.632)
Tranche outstanding principal balance		0.056*		0.501
		(0.032)		(0.321)
Weighted average coupon		−0.260**		−2.466**
		(0.114)		(1.045)
Weighted average loan size		−0.044		−0.349
		(0.086)		(0.683)
Tranche repaid amount		−0.004		−0.008
		(0.005)		(0.038)
Tranche Spread		8.846		80.939*
		(5.695)		(41.856)
Original tranche rating	0.041***	0.050***	0.324***	0.422***
	(0.010)	(0.016)	(0.066)	(0.127)
Delinquency rate	2.718**	7.103***	32.753***	61.350***
	(1.099)	(1.677)	(9.652)	(19.174)
Observations	298	256	205	205
R^2 / Pseudo R^2	0.26	0.33	0.213	0.308
Closing Year FE	YES	YES	YES	YES
Geographic FE	YES	YES	YES	YES
Tranche Maturity FE	YES	YES	YES	YES

Notes: The table presents the results of linear probability model (LPM) and logit regression analysis for the dependent variable *rating variation* which takes the value of 1 if the *original tranche rating* is different from the *current tranche rating* and 0 otherwise. Closing year, geographic and tranche maturity fixed effects are incorporated in regression analysis, where indicated. Robust errors, reported in parentheses, are clustered at the securitisation deal level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, respectively.

Table 7. Robustness: Multinomial Logit model for the signalling hypothesis of subordination.

	(1)	(2)	(3)	(4)
VARIABLES	Multinomial Logit		Multinomial Logit	
	Downgrade	*Upgrade*	*Downgrade*	*Upgrade*
Subordination	−7.427*	−2.088	−7.689*	−1.234
	(4.752)	(4.963)	(4.252)	(6.652)
Pool outstanding principal balance			−0.137	−0.531
			(0.502)	(0.625)
Tranche outstanding principal balance			0.528**	−0.489
			(0.229)	(0.395)
Weighted average coupon			−0.316	−1.889
			(0.755)	(1.397)
Weighted average loan size			−0.086	−0.880
			(0.522)	(0.825)
Tranche repaid amount			−0.016	−0.141**
			(0.034)	(0.071)
Tranche Spread			85.557**	−125.447
			(42.099)	(107.489)
Original tranche rating	0.318***	0.043	0.308***	0.012
	(0.084)	(0.090)	(0.120)	(0.209)
Delinquency rate	26.525**	1.053	27.171**	−0.257
	(10.668)	(11.493)	(11.515)	(18.287)
Observations	298	298	256	256
Pseudo R^2	0.194	0.194	0.242	0.242
Closing Year FE	YES	YES	YES	YES
Geographic FE	YES	YES	YES	YES
Tranche Maturity FE	YES	YES	YES	YES

Notes: The table presents the results of multinomial logit regression analysis for the dependent variable *rating variation_012* which takes the value of 1 in case of *original tranche rating* downgrades, the value of 2 in case of *original tranche rating* upgrades, and 0 otherwise. Closing year, geographic and tranche maturity fixed effects are incorporated in regression analysis, where indicated. Robust errors, reported in parentheses, are clustered at the securitisation deal level. $*** p < 0.01$, $** p < 0.05$, $* p < 0.1$, respectively.

moving from the 10th percentile to the 90th percentile of *subordination* distribution decreases the propensity to perform a downward rating adjustment from 85% to 62%. An explanation of the absence of statistical significance for upgrades is found in Ashcraft, Vickery, and Goldsmith-Pinkham (2010) who state that 'prior to the crisis, 80–95% of a typical subprime or Alt-A mortgage-backed-securities (MBS) deal was assigned the highest possible triple-A rating'. Therefore, further rating upgrades of a substantial share of the tranches are not possible and the statistical link, if any, may be driven by a small number of transactions. Overall, our LPM, logit and multinomial models' results confirm not only the signalling role played by subordination but also the positive effect on tranche rating adjustments over time.

5.1.2. Ordered logit model

In this section, we re-estimate our baseline model of the signalling hypothesis using ordered logit estimation as a suitable parametric model given the ordinal nature of the target variable $\Delta Rating$ to take into account the intensity of the rating variation. In these models we use the OLS model's dependent variable $\Delta Rating$, a categorical variable which ranges from a minimum value of −17 to a maximum value of 3, based on the upward or downward tranche rating adjustments. Specifically, negative values of $\Delta Rating$ reflect the occurrence of rating downgrades whereas positive values of this variable indicate upward ratings' changes. Results of ordered logit estimation are reported in Table 8. We continue to find a positive and significant effect of subordination on rating variation. Thus, our empirical findings are also robust to the alternative estimation method of an ordered logit model.

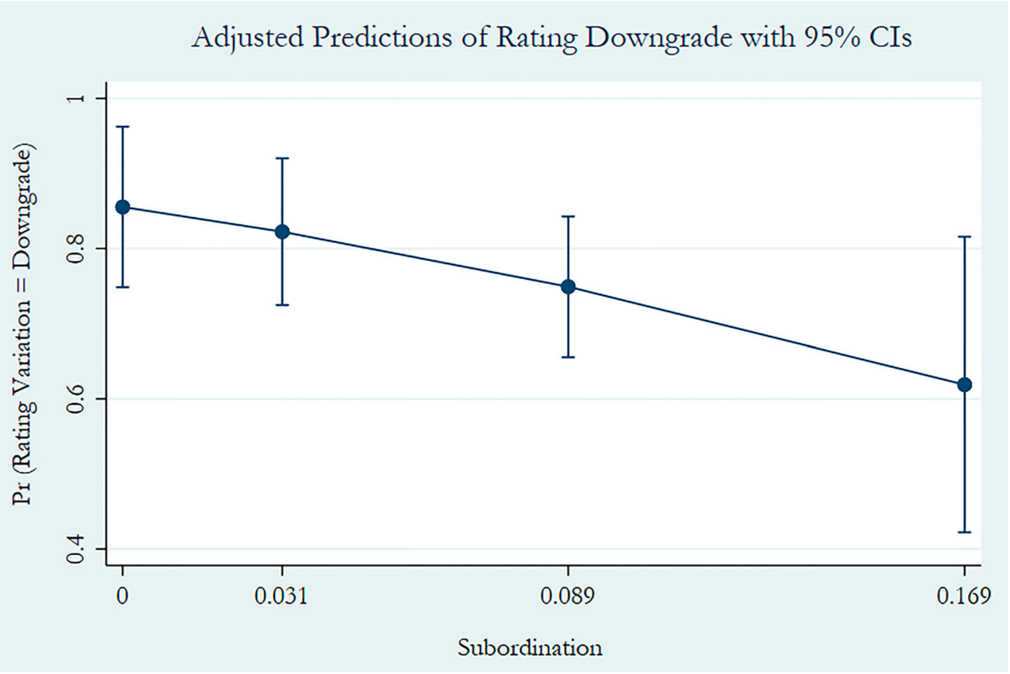

Figure 6. Predicted outcomes of *Rating Downgrade* at percentiles of *Subordination*.
Notes: On the x-axis are reported the, 25th, 50th, 75th, and 90th percentiles of *Subordination* distribution.

5.2. Addressing potential endogeneity concerns

This section considers an instrumental variable method (IV – 2SLS – estimation) to assuage concerns related to the potential endogeneity affecting the degree of subordination as it could be argued that the originator's choice of the senior-subordinated structure for a given securitisation deal might be an endogenous decision on the part of the originator. As a matter of fact, one might argue that the relationship between subordination and either the delinquency rate or tranche rating variation is triggered by an unobserved factor that affects the degree of subordination itself. Thus, the identification strategy requires an exogenous variable that is correlated with the degree of subordination but does not directly influence either the delinquency rate or tranche rating adjustment. We instrument subordination using different instruments for the buffer and the signalling hypothesis of subordination. Regarding the former, we instrument subordination using the *pool outstanding balance* which could be referred to as a pure number affecting the degree of subordination of a given tranche without influencing the pool delinquency rate. Regarding the latter, we instrument subordination using the *current tranche rating* as higher credit ratings are associated with greater subordination levels but they do not influence potential rating variations from the closing date to the data collection date. Hence, none of the instruments seem to have a direct effect on its specific dependent variable, rather their only effect on the dependent variable seems to go via their effect on the endogenous explanatory variable. IV estimation results for the buffer hypothesis are reported in specification (1) of Table 9, while for the signalling hypothesis in specification (2) of Table 9. The validity and relevance of the instruments for subordination are verified using a number of diagnostic tests, such as the Kleibergen-Paap rk Wald F statistic, the Anderson–Rubin Wald test and Underidentification test. The *p*-values for all these statistics are reported in both tables. Moreover, we report the sign and the significance of the coefficients of the instruments in the first stage at the bottom of Table 9. In this regard, first stage results show that the greater the *pool outstanding balance* the lower the degree of subordination and that a higher *current tranche rating* is associated with increased subordination. Table 9 also shows that the coefficients of the instruments in the first stage are significant at the 1% level.

Table 8. Robustness: Ordered Logit model for the signalling hypothesis of subordination.

	(1)	(2)
VARIABLES	Ordered Logit	Ordered Logit
Subordination	5.739**	5.567**
	(2.806)	(2.300)
Pool outstanding principal balance		−0.509
		(0.484)
Tranche outstanding principal balance		−0.183
		(0.203)
Weighted average coupon		0.743
		(0.737)
Weighted average loan size		−0.473
		(0.576)
Tranche repaid amount		−0.020
		(0.031)
Tranche Spread		−15.800
		(24.378)
Original tranche rating	−0.177***	−0.125
	(0.061)	(0.087)
Delinquency rate	−8.444	−32.784***
	(6.548)	(11.759)
Observations	298	256
Pseudo R^2	0.122	0.0929
Closing Year FE	YES	YES
Geographic FE	YES	YES
Tranche Maturity FE	YES	YES

Notes: The table presents the results of ordered logit regression analysis for the dependent variable Δ*Rating* which ranges from a minimum value of −17 to a maximum value of 3, based on the upward or downward *original tranche rating* adjustments. Closing year, geographic and tranche maturity fixed effects are incorporated in regression analysis, where indicated. Robust errors, reported in parentheses, are clustered at the securitisation deal level. $*** p < 0.01$, $** p < 0.05$, $* p < 0.1$, respectively.

Overall, our IV estimation results reported in Table 9 validate a significant effect of subordination on both the pool delinquency rate (buffer hypothesis) and the tranche rating variation over time (signalling hypothesis), thus leaving our main results qualitatively unaffected.

5.3. Generalised structural equation modelling

To assuage concerns related to the fact that both the signalling and the buffering effects of subordination arise simultaneously as a result of two separated analyses conducted by examining the same dataset, we now implement generalised structural equation modelling with the objective to interconnect the two analyses. This approach provides a valid robustness test to identify whether the suggested buffer-signalling dichotomy of subordination does not hold in securitisation since it rules out the possibility that the buffer hypothesis is driven by one part of the data and the signalling hypothesis by another part of our sample of securitisation transactions. Our results for structural equation modelling, reported in Table 10, further validate our main findings about both the buffer and the signalling hypothesis of subordination.

5.4. Different delinquency buckets for the buffer hypothesis

We are now interested in performing an additional test to examine the robustness of our results with respect to the buffer hypothesis. Specifically, to rule out the possibility that our results might be affected by different delinquency buckets, we now test the buffer hypothesis by using three measures of the pool delinquency rate as our dependent variables, i.e. *delinquency rate 30–59* for assets delinquent between 30 and 59 days, (ii) *delinquency rate 60–89* for assets delinquent between 60 and 89 days, and (iii) *delinquency rate 90–120* for assets delinquent between 90 and 120 days. Our results, reported in Table 11, validate our previous findings in that

Table 9. Robustness: IV Estimation for the buffer & signalling hypothesis of subordination.

VARIABLES	(1) IV Estimation Buffer Hypothesis	(2) IV Estimation Signalling Hypothesis
Subordination	0.600***	8.720***
	(0.101)	(3.540)
Observations	256	256
Controls	YES	YES
Closing Year FE	YES	YES
Geographic FE	YES	YES
Tranche Maturity FE	YES	YES
Tests:		
Kleibergen-Paap	0.0008	0.0015
Anderson-Rubin	0.0000	0.0000
Hansen J	0.000 (model exactly identified)	0.000 (model exactly identified)
Weak identification (Kleibergen-Paap rk Wald F statistic)	24.259	9.073
First Stage		
Pool outstanding principal balance	−0.045***	
	(0.009)	
Current tranche rating		0.005***
		(0.001)

Notes: The table reports in column (1) and (2) coefficient estimates and robust standard errors (in parentheses) for the two-stage least squares model of Equations (1) and (3), respectively. The first stage includes all explanatory variables in the second stage. The dependent variables are *delinquency rate* (column 1) and Δ*Rating* (column 2). The Kleibergen-Paap is a test of under-identification distributed as chi-square under the null of under-identification. The Anderson Rubin statistic is weak-instrument-robust inference tests, under the null that coefficients of the endogenous regressors in the structural equation are jointly equal to zero, and the over-identifying restrictions are valid. The Hansen J statistic is a test of the over-identifying restrictions, distributed as chi-square under the null of instrument validity. The first-stage Kleibergen-Paap rk Wald F statistic is a test for weak instrument. All variables are defined in Table 1. In the margin, we report coefficients and standard errors for the two instrumental variables. Closing year, geographic and tranche maturity fixed effects are incorporated in regression analysis, where indicated Robust errors reported in parentheses are clustered at the securitisation deal level. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$, respectively.

they provide evidence of a positive and significant effect of subordination on the pool delinquency rate for all the three aforementioned delinquency buckets.

5.5. Removal of year 2007 from the analysis

To assuage endogeneity issues related to the sample period chosen, we now re-estimate our baseline models for both the buffer and the signalling hypothesis by removing year 2007 from the analysis. We do this as the securitisation market started to be impacted from the onset of the financial crisis, i.e. from June 2007 onwards. This is performed in order to investigate whether our previous results might be influenced by the US subprime mortgage crisis. Results are shown in Table 12. Once again, the effect of subordination on either the pool delinquency rate or rating changes is further validated as it remains qualitatively unchanged.

5.6. Originator creditworthiness

In order to strengthen the robustness of our findings, we are interested in testing whether our main results hold when we account for the originator's credit quality to control for unobserved heterogeneity at the originator-level which may affect our main results.

Table 10. Robustness: Generalized Structural Equation Modelling for the buffer & signalling hypothesis of subordination.

	(1)	(2)
VARIABLES	GSEM Buffer Hypothesis	GSEM Signalling Hypothesis
Subordination	0.233***	18.314***
	(0.050)	(6.756)
Delinquency rate		−54.686***
		(14.677)
Original tranche rating		−0.477***
		(0.118)
Current tranche rating	−0.004***	
	(0.001)	
Observations	298	298
Controls	YES	YES
Closing Year FE	YES	YES
Geographic FE	YES	YES
Tranche Maturity FE	YES	YES

Notes: The table presents the results of generalised structural equation modelling for the dependent variables *delinquency rate* (column 1) and Δ*Rating* (column 2). Closing year, geographic and tranche maturity fixed effects are incorporated in regression analysis, where indicated. Robust errors, reported in parentheses, are clustered at the securitisation deal level. $***\, p < 0.01$, $**\, p < 0.05$, $*\, p < 0.1$, respectively.

Table 11. Robustness: Model for the buffer hypothesis of subordination according to the different buckets of delinquency.

	(1)	(2)	(3)
VARIABLES	OLS	OLS	OLS
Subordination	0.039***	0.021***	0.024***
	(0.014)	(0.008)	(0.006)
Pool outstanding principal balance	−0.013***	−0.006***	−0.004***
	(0.002)	(0.001)	(0.001)
Tranche outstanding principal balance	0.001*	0.000	−0.000
	(0.001)	(0.000)	(0.000)
Weighted average coupon	0.009	0.007**	0.006*
	(0.006)	(0.003)	(0.004)
Weighted average loan size	0.005*	0.001	0.002
	(0.003)	(0.002)	(0.002)
Tranche repaid amount	−0.000	−0.000	0.000
	(0.000)	(0.000)	(0.000)
Tranche Spread	0.168	0.103	0.193***
	(0.129)	(0.073)	(0.063)
Current tranche rating	−0.001***	−0.000**	−0.000
	(0.000)	(0.000)	(0.000)
Observations	248	244	243
R^2	0.75	0.68	0.70
Closing Year FE	YES	YES	YES
Geographic FE	YES	YES	YES
Tranche Maturity FE	YES	YES	YES

Notes: The table presents the results of OLS regression analysis for the dependent variables *delinquency rate 30–59* (column 1), *delinquency rate 60–89* (column 2), and *delinquency rate 90–120* (column 3). Closing year, geographic and tranche maturity fixed effects are incorporated in regression analysis, where indicated. Robust errors, reported in parentheses, are clustered at the securitisation deal level. $***\, p < 0.01$, $**\, p < 0.05$, $*\, p < 0.1$, respectively.

Firstly, we test whether our results on the use of subordination as a buffer mechanism for more senior investors hold when we take into account the credit quality of the originator (Faltin-Traeger, Johnson, and Mayer 2010, 2011; Titman and Tsyplakov 2010). To this end, we split the originators' sample into high and low credit quality originators by considering the originator's rating collected from both S&P's SNL and Thomson Reuter's Eikon databases. We then replicate the same model of Equation (1) by interacting subordination with the dummy

Table 12. Robustness: Removal of year 2007 from the analysis.

VARIABLES	(1) OLS Buffer Hypothesis	(2) OLS Signalling Hypothesis
Subordination	0.081∗∗∗	7.815∗∗
	(0.021)	(4.113)
Pool outstanding principal balance	−0.021∗∗∗	−0.287
	(0.004)	(0.859)
Tranche outstanding principal balance	0.001	−0.419
	(0.001)	(0.340)
Weighted average coupon	0.026∗	0.797
	(0.014)	(1.304)
Weighted average loan size	0.006	−0.493
	(0.006)	(0.867)
Tranche repaid amount	−0.000	−0.052
	(0.000)	(0.050)
Tranche Spread	0.520∗∗	23.470
	(0.239)	(43.325)
Original tranche rating		−0.072
		(0.152)
Delinquency rate		−41.336∗∗
		(19.534)
Current tranche rating	−0.001∗∗∗	
	(0.000)	
Observations	227	227
R^2	0.76	0.39
Closing Year FE	YES	YES
Geographic FE	YES	YES
Tranche Maturity FE	YES	YES

Notes: The table presents the results of OLS regression analysis for the dependent variables *delinquency rate* (column 1) and Δ*Rating* (column 2) obtained when removing year 2007 from the analysis. Closing year, geographic and tranche maturity fixed effects are incorporated in regression analysis, where indicated. Robust errors, reported in parentheses, are clustered at the securitisation deal level. ∗∗∗ $p < 0.01$, ∗∗ $p < 0.05$, ∗ $p < 0.1$, respectively.

variable *creditworthy originator*, which takes the value of 1 every time we observe the originator's credit rating falling in the A rating class according to either both SNL or Eikon and 0 otherwise; this process leads to the creation of the interaction term *subordination∗creditworthy originator*. In this regard, the results, reported in Table 13, suggest that the insurance effect provided by subordination is stronger when the originator is less creditworthy due to the potential lower quality of the underlying assets being securitised and the greater intrinsic riskiness of the securitised assets themselves.

Secondly, we test whether our results on the use of subordination as a signalling device for the unobserved credit quality of securitised assets hold even when we take the credit quality of the originator into account (Faltin-Traeger, Johnson, and Mayer 2010, 2011; Titman and Tsyplakov 2010). To this end, we split the originators' sample into high and low credit quality originators by considering the originator's rating collected from both S&P's SNL and Thomson Reuter's Eikon databases. We then replicate the same model of Equation (3) by interacting subordination with the dummy variable *creditworthy originator*, which takes the value of 1 every time we observe the originator's credit rating falling in the A rating class according to either both SNL or Eikon and 0 otherwise; this process leads to the creation of the interaction term *subordination∗creditworthy originator*. The results, reported in Table 14, show that the positive effect of subordination on subsequent tranche rating variations is stronger when the originator is more creditworthy due to a possible reputational effect in the market.[22]

Overall, the robustness tests performed by taking into account the credit quality of the originator leave our previous findings qualitatively unchanged with respect to both the buffer and the signalling hypothesis of subordination in line with Faltin-Traeger, Johnson, and Mayer (2010, 2011) and Titman and Tsyplakov (2010).

5.7. Originator fixed effects

Besides taking into account the credit quality of the originator, as a further robustness test, we replicate the baseline models for both the buffer and the signalling hypotheses by controlling for the originator's identity, i.e. *originator fixed effects*. We do this to wipe out concerns that our results may be influenced by the behaviour of the originating institutions in the specific credit boom period under analysis, in which some originators behaved more recklessly than others due to potential rating agencies' collusive behaviours with banks. Therefore, issuer specific characteristics (such as a certain bank lending policy) are likely to have an impact on pool performance. Our estimation results with *originator fixed effects* are reported in Table 15. Again, even if we include *originator fixed effects* in our empirical analysis, our previous findings remain robust with respect to both the buffer and the signalling hypothesis of subordination.

5.8. Deal fixed effects

Furthermore, we re-estimate our baseline models for both the buffer and the signalling hypothesis of subordination by controlling for *deal fixed effects*, as the tranches connected to the same deal are likely to be impacted from deal-specific factors. Our estimation results with *deal fixed effects* are reported in Table 16. Even the inclusion of *deal fixed effects* in our empirical analysis leaves our previous findings robust with respect to both the buffer and the signalling hypothesis of subordination.[23]

6. Conclusions

In this study we provide novel evidence to the existing literature by empirically investigating whether the buffer or the signalling effect of subordination prevails in securitisation transactions. As a matter of fact, in

Table 13. Robustness: Model for the buffer hypothesis of subordination according to originator's creditworthiness.

	(1)	(2)	(3)	(4)
VARIABLES	OLS	OLS	OLS	OLS
Subordination	0.088***	0.084***	0.084***	0.086***
	(0.029)	(0.031)	(0.022)	(0.022)
Subordination*creditworthy originator	0.023	−0.021	−0.041	−0.015
	(0.068)	(0.073)	(0.043)	(0.044)
Creditworthy originator	−0.000	0.002	0.008	0.009
	(0.007)	(0.006)	(0.007)	(0.007)
Pool outstanding principal balance	−0.019***	−0.018***	−0.024***	−0.024***
	(0.005)	(0.005)	(0.004)	(0.004)
Tranche outstanding principal balance	0.000	0.000	0.001	0.001
	(0.002)	(0.002)	(0.001)	(0.001)
Weighted average coupon	0.009	0.010	0.025*	0.028**
	(0.013)	(0.013)	(0.014)	(0.014)
Weighted average loan size	0.006	0.006	0.007	0.004
	(0.006)	(0.006)	(0.006)	(0.008)
Tranche repaid amount	0.000	0.000	−0.000	−0.000
	(0.000)	(0.001)	(0.000)	(0.000)
Tranche Spread	1.005***	0.960**	0.494**	0.535**
	(0.356)	(0.395)	(0.239)	(0.229)
Current tranche rating	−0.000	−0.000	−0.001***	−0.001***
	(0.001)	(0.001)	(0.000)	(0.000)
Observations	198	198	198	198
R^2	0.55	0.53	0.76	0.77
Closing Year FE	YES	NO	NO	YES
Geographic FE	NO	YES	NO	YES
Tranche Maturity FE	NO	NO	YES	YES

Notes: The table presents the results of OLS regression analysis for the dependent variable *delinquency rate*. Subordination is interacted with the dummy *creditworthy originator* giving rise to the interaction term *subordination*creditworthy originator* to capture the differential effect of subordination on the delinquency rate based on the originator's credit quality. Closing year, geographic and tranche maturity fixed effects are incorporated in regression analysis, where indicated. Robust errors, reported in parentheses, are clustered at the securitisation deal level. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$, respectively.

Table 14. Robustness: Model for the signalling hypothesis of subordination according to originator's creditworthiness.

	(1)	(2)	(3)	(4)
VARIABLES	OLS	OLS	OLS	OLS
Subordination	10.408**	10.517**	13.526***	12.976***
	(4.899)	(4.822)	(4.348)	(4.347)
Subordination*creditworthy originator	20.599*	19.229*	21.931*	23.015*
	(13.129)	(14.543)	(14.762)	(14.369)
Creditworthy originator	1.646	1.017	1.697	2.206
	(1.468)	(1.476)	(1.529)	(1.823)
Pool outstanding principal balance	1.465	1.175	−0.457	−0.457
	(0.954)	(1.058)	(0.777)	(0.706)
Tranche outstanding principal balance	−0.513	−0.471	−0.325	−0.323
	(0.359)	(0.389)	(0.362)	(0.349)
Weighted average coupon	0.462	0.416	2.284	2.793
	(1.183)	(1.289)	(1.643)	(1.671)
Weighted average loan size	0.306	−0.175	−0.329	−0.176
	(1.213)	(1.270)	(0.938)	(0.790)
Tranche repaid amount	0.043	0.073	−0.017	−0.018
	(0.055)	(0.062)	(0.048)	(0.046)
Tranche Spread	−54.046	−66.113	−26.874	−25.997
	(44.426)	(45.172)	(49.646)	(49.648)
Original tranche rating	−0.321*	−0.413**	−0.382*	−0.369*
	(0.166)	(0.194)	(0.209)	(0.191)
Delinquency rate	−1.393	−1.910	−46.994**	−49.499***
	(23.572)	(26.754)	(19.758)	(18.310)
Observations	198	198	198	198
R^2	0.19	0.12	0.42	0.43
Closing Year FE	YES	NO	NO	YES
Geographic FE	NO	YES	NO	YES
Tranche Maturity FE	NO	NO	YES	YES

Notes: The table presents the results of OLS regression analysis for the dependent variable $\Delta Rating$. Subordination is interacted with the dummy *creditworthy originator* giving rise to the interaction term *subordination*∗*creditworthy originator* to capture the differential effect of subordination on the subsequent tranche rating variations based on the originator's credit quality. Closing year, geographic and tranche maturity fixed effects are incorporated in regression analysis, where indicated. Robust errors, reported in parentheses, are clustered at the securitisation deal level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, respectively.

securitisation, substantial attention is devoted to the senior-subordinated structure since the latter could be designed not only to determine the level of protection of securities' holders (buffer effect) but also to mitigate the information asymmetry that characterises securitisation (signalling effect). On the one hand, according to the buffer hypothesis, subordination acts as a buffer against observable risk, particularly when borrowers are relatively risky from a credit quality standpoint, since it protects securities' investors from higher delinquency rates on securitised assets. On the other hand, according to the signalling hypothesis, subordination serves as a signal of unobservable credit quality with the objective to mitigate information asymmetries rooted in securitisation transactions by conveying informed sellers' private information on the securitised pool to uninformed buyers in the market.

To the best of our knowledge, this study represents the first attempt to directly test for this dual effect of subordination in the same study by using granular deal- and tranche-level data on a portfolio of 100 RMBS securitisation deals originating in nine countries and closing between 2005 and 2007. Our empirical results are of international relevance and reveal that, in securitisation, the senior-subordinated structure serves not only as a buffer against observable risk but also as a signal of the originator's confidence in the credit quality of the assets sold to securities' investors in the market. Therefore, our findings provide novel evidence that the role of subordination in securitisation is twofold and highlight the absence of a real buffer-signalling dichotomy.

Despite the granularity and the depth of the data that make our empirical setting unique, we acknowledge some limitations of the current study which pertain to the sample size and period under analysis which

Table 15. Robustness: Models for the buffer & signalling hypothesis of subordination with originator fixed effects.

	(1)	(2)
VARIABLES	OLS Buffer Hypothesis	OLS Signalling Hypothesis
Subordination	0.001**	7.458**
	(0.000)	(3.854)
Pool outstanding principal balance	−0.012***	−0.332
	(0.000)	(0.459)
Tranche outstanding principal balance	−0.000***	−0.287
	(0.000)	(0.323)
Weighted average coupon	−0.017***	50.206***
	(0.000)	(1.524)
Weighted average loan size	−0.016***	18.103***
	(0.000)	(0.666)
Tranche repaid amount	−0.000**	0.037
	(0.000)	(0.042)
Tranche Spread	0.000***	−54.566
	(0.000)	(34.746)
Original tranche rating		−0.275**
		(0.123)
Delinquency rate		−45.193***
		(3.522)
Current tranche rating	0.000***	
	(0.000)	
Observations	256	256
R^2	0.92	0.82
Closing Year FE	YES	YES
Geographic FE	YES	YES
Tranche Maturity FE	YES	YES
Originator FE	YES	YES

Notes: The table presents the results of OLS regression analysis for the dependent variables *delinquency rate* (column 1) and Δ*Rating* (column 2) obtained when including originator fixed effects. Closing year, geographic, tranche maturity, and originator fixed effects are incorporated in regression analysis, where indicated. Robust errors, reported in parentheses, are clustered at the securitisation deal level. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$, respectively.

could be expanded by covering more recent times to account more closely for the new rules and regulations on securitisation that were imposed after the financial crisis in both the US and Europe.

Our conclusions are relevant from a policy perspective in light of the recent agreement reached by European lawmakers with national governments to revive the European securitisation markets. Our findings lead to a better understanding of the role played by credit enhancements in securitisation in terms of protection (i.e. buffer) or self-regulation (i.e. signalling) mechanisms that could enhance the framework of securitisation activity not only by offering protection consistent with investors' risk profiles but also by reaching a stronger alignment of interests between originators and third-party investors in the market. Since informational frictions are still pervasive in the securitisation market, the relevance of our results extends to the current conditions that follow a period of post-crisis regulatory changes, despite this study examines the data generated prior to the post-crisis regulatory response to securitisation. We indeed believe that any mechanism that enables mitigating information asymmetries between originators and investors should be one of the main concerns in the redesign of the securitisation markets. In turn, a well-redesigned, and well-integrated securitisation market across the European Economic Area ultimately increases the lending capacity of banks to the real economy by freeing up bank capital and thus expanding the flow of credit to the real economy.

This study paves the way for future research in this field. Our results call for further investigation of the buffer and the signalling hypothesis of subordination in the post-crisis period to check for the existence of different equilibria pre- vs post-crisis, for the examination of different forms of credit enhancements other than the senior-subordinated structure as well as for the analysis of different RMBS by mortgage type and of other asset classes subject to securitisation other than RMBS.

Table 16. Robustness: Models for the buffer & signalling hypothesis of subordination with deal fixed effects.

VARIABLES	(1) OLS Buffer Hypothesis	(2) OLS Signalling Hypothesis
Subordination	0.001***	7.458**
	(0.000)	(3.865)
Pool outstanding principal balance	0.704***	0.369
	(0.000)	(0.373)
Tranche outstanding principal balance	0.000***	−0.287
	(0.000)	(0.324)
Weighted average coupon	−0.054***	0.469
	(0.000)	(0.492)
Weighted average loan size	−0.650***	−1.773***
	(0.000)	(0.484)
Tranche repaid amount	−0.000**	0.037
	(0.000)	(0.042)
Tranche Spread	−0.000	−54.566
	(0.000)	(34.842)
Original tranche rating		−0.275**
		(0.124)
Delinquency rate		−269.748***
		(16.950)
Current tranche rating	−0.000***	
	(0.000)	
Observations	256	256
R^2	0.92	0.82
Closing Year FE	YES	YES
Geographic FE	YES	YES
Tranche Maturity FE	YES	YES
Deal FE	YES	YES

Notes: The table presents the results of OLS regression analysis for the dependent variables *delinquency rate* (column 1) and Δ*Rating* (column 2) obtained when including deal fixed effects. Closing year, geographic, tranche maturity, and deal fixed effects are incorporated in regression analysis, where indicated. Robust errors, reported in parentheses, are clustered at the securitisation deal level. $***p < 0.01$, $**p < 0.05$, $*p < 0.1$, respectively.

Notes

1. European Commission (2019). 'Factsheets on the Commission's 10 priorities', Publications Office of the European Union, May.
2. A swift implementation of the securitisation package could unlock up to €150 billion in additional funding to the real economy, particularly for SMEs and startups.
3. More diversified funding sources could boost SME funding in normal times while providing resilience against financial shocks. Broader access to finance would limit the exposure of SMEs to banking sector difficulties and help to ensure the flow of credit to viable firms across the various stages of the business cycle, thereby reducing the vulnerability of the economy to financial shocks (Aiyar et al. 2015).
4. Internal credit enhancements may be the cash reserve funds generated with the proceeds of the ABS issue, the excess servicing spread account, fed with the difference between the cash flows from the securitised pool of assets and the cash flows to ABS holders, the overcollateralization, computed by the difference between the intrinsic estimated value of the securitised assets and the par value of the ABS to be issued, the senior-subordinated structure (credit tranching) redistributing the credit risk among different tranches of the ABS issue and the change in the amortization schedule of the ABS issue if a 'trigger event' occurs related to the originator, to the securitised pool of assets or to other players involved in the transaction (Filomeni 2011). External enhancements may include a corporate guarantee, such as a guarantee issued by a parent company, a letter of credit issued by a bank or by a finance company and an insurance contract, mainly provided by the so-called monoline insurer represented by an insurance company that is restricted, by the terms of its charter, to writing insurance policies related to a single type of risk (Filomeni 2011).
5. The authors define subordination as 'the most popular form of credit enhancement in securitisation in which deals follow a senior-subordinated structure'.
6. The 'buffer hypothesis' is particularly sound when the securitised assets comprising the pool are demonstrably risky from a credit quality standpoint (Berger and Udell 1990; Ashcraft and Schuermann 2008; Mandel, Morgan, and Wei 2012).

7. Countries of origin of the assets being securitised considered in our empirical analysis are Italy, Germany, Greece, Ireland, the Netherlands, Portugal, Spain, the United Kingdom and the United States. A breakdown of the number of securitisation deals originated in each individual country is provided in table A1 in the Appendix.
8. For instance, the amount of subordination at a given rating class is the fraction of bonds that absorb losses before the bond in question. If 90 percent of the bonds in a securitisation deal are senior AAA bonds and 10 percent are junior, subordination of the AAA bonds is 10 percent, where each tranche has a legal reimbursement priority. Moreover, each tranche is assigned a rating by a specialized rating agency on the basis of the priority claim on the expected cash flows underlying the given securitisation deal. Indeed, ratings for an MBS deal are typically described in terms of the 'subordination level' or 'attachment point' of each rating, which is the fraction of the deal junior to the bonds of that letter rating (Ashcraft, Vickery, and Goldsmith-Pinkham 2010).
9. The level of credit enhancements, necessary in order to achieve a specific rating, is computed based on a mechanical procedure reflecting the rating agency's expected loss function on the securitised assets (Ashcraft and Schuermann 2008).
10. The author uses the expression 'moral hazard' to indicate the change in incentives arising when originators do not bear the full consequences of or responsibility for their actions and, therefore, pay too little attention to the riskiness of the loans they originate and place into pools subject to securitisation.
11. It is worthwhile to mention that the ability of the originators to sell the junior piece reduces the cost of signalling loan pool quality, i.e., originators with unobservably poorer credit quality pools can mimic those with good quality pools at a lower cost (Begley and Purnanandam 2016).
12. If there is no information asymmetry between the two agents, there is no need to incur this signalling cost.
13. SDC Platinum is a database developed and monitored by Thomson Reuters.
14. Global Credit Portal is a database developed and fed by the rating agency Standard & Poor's (S&P).
15. Our database-generating process entails two critical issues we must overcome in order to successfully perform our econometric analysis: the first issue relates to data collection, while the second issue concerns the collected data-merging process. Since information, even if consistent across the separate tearsheets, is often asymmetrically-distributed in the XML-format tearsheets comprising our statistical sample, we had to program and execute a macro to yield a spreadsheet integrating data contained in our XML-tearsheets in a consistent and ordered pattern, being careful not to experience any information loss.
16. Countries of origin of the assets being securitised considered in our empirical analysis are Italy, Germany, Greece, Ireland, the Netherlands, Portugal, Spain, the United Kingdom and the United States.
17. We collect data in the last quarter of 2012 on all available S&P securitisation tearsheets in the period 2005–2007, as we obtained access to the S&P Global Credit Portal database during that time period. We only consider residential loans securitised from 2005 to 2007, as during the financial crisis the RMBS market dried up.
18. The impact of explanatory variables on the delinquency rate is computed using the 'margins' command in Stata, keeping all the other variables at the average.
19. A description of S&P's rating scale is provided in table A1 in the Appendix to this paper.
20. Again, the impact of explanatory variables on the rating variation is computed using the 'margins' command in Stata, keeping all the other variables at the average.
21. All control variables in regression analysis, except for the *original tranche rating* and the *current tranche rating*, are log transformed.
22. We do not investigate the results per country in the case of the signalling hypothesis, since the relationship between subordination and the subsequent tranche rating variation should not be considered country-specific. Nevertheless, we control for possible variations at the country level (e.g. regulatory framework, macroeconomic shock etc.) by including country fixed effects in all our performed regressions.
23. In unreported regressions, we use rating fixed effects instead of continuous/binary variables to model rating classes and, even in this case, our main findings remain unchanged.

Acknowledgements

We are grateful to the Editor Chris Adcock, to the Associate Editor who coordinated the editorial process, and to two anonymous referees for their valuable insights and suggestions. We also thank David Marqués-Ibáñez, Elena Tabacco, Greg Udell, Alberto Zazzaro, and participants at the research seminars held at Polytechnic University of Marche (Ancona, Italy) for providing very constructive comments on preliminary versions of this paper.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix

Table A1. S&P's rating scale: categories and definitions.

Category	Definition
AAA	An obligor rated 'AAA' has extremely strong capacity to meet its financial commitments. 'AAA' is the highest issuer credit rating assigned by S&P Global Ratings.
AA	An obligor rated 'AA' has very strong capacity to meet its financial commitments. It differs from the highest-rated obligors only to a small degree.
A	An obligor rated 'A' has strong capacity to meet its financial commitments but is somewhat more susceptible to the adverse effects of changes in circumstances and economic conditions than obligors in higher-rated categories.
BBB	An obligor rated 'BBB' has adequate capacity to meet its financial commitments. However, adverse economic conditions or changing circumstances are more likely to weaken the obligor's capacity to meet its financial commitments.
BB, B, CCC, and CC	Obligors rated 'BB', 'B', 'CCC', and 'CC' are regarded as having significant speculative characteristics. 'BB' indicates the least degree of speculation and 'CC' the highest. While such obligors will likely have some quality and protective characteristics, these may be outweighed by large uncertainties or major exposure to adverse conditions.
BB	An obligor rated 'BB' is less vulnerable in the near term than other lower-rated obligors. However, it faces major ongoing uncertainties and exposure to adverse business, financial, or economic conditions that could lead to the obligor's inadequate capacity to meet its financial commitments.
B	An obligor rated 'B' is more vulnerable than the obligors rated 'BB', but the obligor currently has the capacity to meet its financial commitments. Adverse business, financial, or economic conditions will likely impair the obligor's capacity or willingness to meet its financial commitments.
CCC	An obligor rated 'CCC' is currently vulnerable and is dependent upon favorable business, financial, and economic conditions to meet its financial commitments.
CC	An obligor rated 'CC' is currently highly vulnerable. The 'CC' rating is used when a default has not yet occurred but S&P Global Ratings expects default to be a virtual certainty, regardless of the anticipated time to default.
SD and D	An obligor is rated 'SD' (selective default) or 'D' if S&P Global Ratings considers there to be a default on one or more of its financial obligations, whether long- or short-term, including rated and unrated obligations but excluding hybrid instruments classified as regulatory capital or in nonpayment according to terms. A 'D' rating is assigned when S&P Global Ratings believes that the default will be a general default and that the obligor will fail to pay all or substantially all of its obligations as they come due. An 'SD' rating is assigned when S&P Global Ratings believes that the obligor has selectively defaulted on a specific issue or class of obligations but it will continue to meet its payment obligations on other issues or classes of obligations in a timely manner. A rating on an obligor is lowered to 'D' or 'SD' if it is conducting a distressed exchange offer.
***Ratings from 'AA' to 'CCC' may be modified by the addition of a plus (+) or minus (-) sign to show relative standing within the rating categories.**	

Source: S&P's official website, www.standardandpoors.com.

Table A2. List of countries by asset origination.

Country of origination	N. of securitisation deals	%
Italy	35	8.73
Germany	26	6.48
Greece	6	1.5
Ireland	23	5.74
The Netherlands	42	10.47
Portugal	17	4.24
Spain	139	34.66
United Kingdom	64	15.96
United States	49	12.22

Source: Standard & Poor's Global Credit Portal database.