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Post-graduation from the original sin problem The effects of investor participation on sovereign debt markets

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Post-graduation from the original sin problem

The effects of investor participation on sovereign debt markets*

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Abstract

We examine the impact of sovereign debt structure on bond yields and volatility across different maturities and investor types. Using a unique Colombian panel dataset encompassing all government bond maturities held by public and private institutions from 2006 to 2018, our analysis reveals that a one-standard-deviation increase in non-residents' market share leads to a 0.5% reduction in bond yields and a 10% decrease in volatility relative to their mean values. For domestic banks and pension funds, a one-standard-deviation increase in market shares results in a 0.7% and 1.3% increase in bond yields, along with a 10% and 6% rise in yield volatility, respectively. Additionally, we observe unexpected negative effects of foreign investors' market concentration on bond yields and volatility. These effects are attributed to the mix of investors. Initially, all foreign investors were foreign banks, demonstrating stable demand despite their limited number. Over time, they ceded participation to mutual funds, which, although more numerous, adopted speculative strategies associated with short-term return investments.

JEL Classification: E43, G01, G11, G15

Keywords: Debt term structure; bond market participation; bond market concentration; sovereign bond holdings

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Los Efectos de la Participación y Concentración de los Títulos de Deuda Pública en Colombia

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Resumen

Examinamos el impacto de la estructura de la deuda soberana en los rendimientos y volatilidad de los bonos a través de diferentes madureces y tipos de inversores. Utilizando un panel de datos que abarca todas las madureces de bonos del gobierno colombiano en manos de instituciones públicas y privadas entre 2006 y 2018, encontramos que un aumento de una desviación estándar en la participación de mercado por parte de inversores extranjeros reduce en 0.5% los rendimientos de los bonos y en 10% su volatilidad, con respecto a sus promedios. Para los bancos y fondos de pensiones domésticos, un aumento de una desviación estándar en sus participaciones aumenta en 0.7% y 1.3% los rendimientos de los bonos, y en 10% y 6% su volatilidad, respectivamente. Además, encontramos que aumentos en la concentración de los inversores extranjeros reducen los rendimientos y la volatilidad de los bonos. Estos efectos se atribuyen a la composición de los inversores. Inicialmente, todos los inversores extranjeros eran bancos extranjeros, quienes demostraban una demanda estable a pesar de su reducido número. Con el tiempo, cedieron participación a fondos mutuos quienes, aunque más numerosos, adoptaron estrategias asociadas con retornos de corto plazo.

Clasificación JEL: E43, G01, G11, G15

Palabras Clave: Estructura de la deuda pública; participación en el mercado de bonos; concentración en el mercado de bonos; tenencia de bonos soberanos

1 Introduction

Until the 2008-09 financial world crisis, foreign investors had continuously increased their presence in the global bond markets for emerging countries' government securities. This changed in the aftermath of the crisis when private banks and pension funds shifted their focus toward the domestic bond markets for such securities. For many countries, this shift signaled an end to their so-called "*original sin*" problem -i.e., the inability to issue long-term debt in domestic currency (Eichengreen and Hausmann, 1999). Moreover, it carried a major recomposition of the investor base. This had important policy implications, as the tides and ebbs of capital flows are usually scaled up by the mix of investors' bond holdings. Paradoxically, little is known about the effects of the sovereign debt structure among financial players, an issue that lies at the heart of our research.

While there is considerable heterogeneity regarding the composition of countries' government debt structures, there seem to be two key stylized facts: (i) countries with developed financial systems tend to have a more diversified investor base, and (ii) in many countries, non-resident holders take up the largest share of the investor base (Andritzky, 2012). In the euro area, for example, the share of foreign investors in countries like Slovenia or Finland is close to 90%, while in Germany and France the share is close to 60%. According to De Santis and Gérard (2006), this high share of cross-holdings by non-residents is in part due to equal regulatory treatment and the perception of homogenous credit risk. In other advanced economies, such as the United States and Japan, foreign participation is closer to 30%. With less data availability, foreign participation in emerging markets usually ranges from 5-30%, even though it has increased significantly since the 2000's.[1]

To date, the existing literature is still divided regarding the effects of foreign participation in sovereign bond markets. On the one hand, authors such as Calvo and Mendoza (1996), Calvo and Talvi (2005), and Cerutti et al. (2019) show that foreign participation in emerging markets can have negative effects when hit by a sudden drying-up of capital flows resulting from an increase in risk aversion. Along this line, Miyajima and Shim (2014) state that foreign investors may destabilize asset markets in emerging markets, accentuating booms and busts. More generally, Obstfeld (2012), Ebeke and Lu (2015), and Ebeke and Kyobe (2015) argue that increased foreign participation in local currency markets is associated with increased sensitivity of overall portfolio flows to global financial conditions and increased

[1] See the 2017 Treasury International Capital Survey and the OECD Sovereign Borrowing Outlook.

volatility of yields.

On the flip side, authors such as Prasad and Rajan (2008) and Peiris (2010) argue that foreign participation can instead dampen volatility in bond yields, especially in emerging markets. The reasoning is that foreign investors act as catalysts for the development of local bond markets by diversifying the institutional investor base and creating greater demand (and liquidity) for local debt securities. Also, according to Burger and Warnock (2004), foreign participation may stabilize markets by reducing currency mismatches and serving as an alternative source of funding.

We shed light on these issues by evaluating the effects of the sovereign debt structure on the level and volatility of bond yields. Particularly, we examine the effects of various degrees of bond market shares (across investor groups) and market concentrations (within investor groups). Our case study centers on the Colombian experience during 2006-2018. Specifically, we focus on the three largest investor groups in the Colombian sovereign debt market: foreigners (i.e. non-residents), pension funds, and commercial banks. We use a unique monthly panel dataset comprised of all government bond maturities in the hands of each public and private financial institution. Hence, to the best of our knowledge, this research is the first to evaluate the relationship between bond concentration and prices within each bond maturity and investor type. While our initial sample date is dictated by data availability, we note that major events –including the financial crisis of 2008-09, and the major surge of international investors to Colombia in 2014– are included in our analysis.

We recognize that under this setting, debt holdings (and prices) might be subject to a simultaneity bias. For instance, foreign investors might react and divert resources from volatile markets, but can also induce market volatility when investing or withdrawing funds. In addition, long-term interest rates can be influenced by unobserved variables related to market expectations, resulting in an omitted variable bias (Wu, 2006; Beltran et al., 2013). These challenges, coupled with the fact that data on entity-specific bond holdings is scarce (and mostly proprietary), are probably why the literature on the effects of the debt structure is rather limited. For example, Ebeke and Lu (2015) resort to aggregate data and state that "while it would have been useful to break down foreign holdings into the various types of holders, this level of disaggregation is not available".

To address endogeneity issues, we incorporate relevant lagged market shares and concentrations while employing bond maturity and time fixed effects. These controls enable us to mitigate the influence of demand-driven fundamentals, such as country risk, on our

results. For robustness, we adopt an instrumental variable approach, using the two-quarter lags of market shares and concentrations as instruments. We also apply the one-step GMM estimation method proposed by Arellano and Bover (1995).

Our results can be categorized into two groups: those related to market participation and those related to market concentration. Concerning the former, we find that a one standard deviation increase in non-residents' market share reduces bond yields by 0.035 percentage points (p.p.) (0.5% relative to its mean value) and yield volatility by 0.02 p.p. (10% relative to its mean value). These results highlight the advantages of having active foreign participation in local bond markets, which reduces government financing costs and makes the bond market less sensitive to financial shocks. Contrarily, a one standard deviation increase in the market shares of local banks and pension funds raises bond yields by 0.052 p.p. (0.7% relative to its mean value) and 0.1 p.p. (1.3% relative to its mean value), as well as yield volatility by 0.02 p.p. and 0.013 p.p. (10% and 6% relative to their mean values), respectively.

Regarding market concentration, we observe a negative effect on bond yields and yield volatility attributed to foreign investors, with no significant effects found for either banks or pension funds. Specifically, a one standard deviation increase in non-residents' market concentration results in a reduction in bond yields by 0.08 p.p. (1.1% relative to its mean value) and volatility by 0.02 p.p. (10% relative to its mean value). At face value, this result is surprising, as one would expect similar effects driven by a more competitive and, thus, less concentrated market. However, the explanation lies in the type of foreign investors. Initially, all foreign investors in Colombia were foreign banks, exhibiting stable demand despite their limited number. This changed at the beginning of the 2010s with the marked entrance of mutual funds, which took the lion's share among foreigners. Consequently, while the number of foreign investors grew, making the market less concentrated, the predominant strategy (common in mutual funds) was associated with short-term return investments and quick reversals based on performance, which deteriorated the market.

In general, our findings are somewhat different from those in Ebeke and Kyobe (2015) and Ebeke and Lu (2015) who find that, while higher foreign participation decreases yields, it also increases yield volatility. In our case, and more in line with Prasad and Rajan (2008) and Peiris (2010), foreign holdings of sovereign bonds reduce both. Regarding market concentration (especially within investor groups) and its effects on bond prices, the literature is scant. There are, nonetheless, studies that evaluate market concentration on other bank,

firm, or financial variables. Such is the case of de Haan and Poghosyan (2012) who find that concentrated markets have experienced higher volatility during the recent financial crisis. Also, Mihov and Naranjo (2017) find that firms with a more concentrated customer base have higher idiosyncratic volatility.

We note that in the related literature, studies typically conduct inference based on only one benchmark bond maturity (often the 5-year bonds).[2] Instead, we observe every traded maturity, allowing us to control for heterogeneous effects across different segments of the yield curve and thus gain a broader perspective on the entire interest rate structure (external validity). When differentiating by segments of the yield curve, we note that pension funds exhibit a strong preference for long-term maturity bonds, while banks prefer short-term bonds. Foreigners, on the other hand, changed their preference from the short end towards long-term maturities since 2012. To further elaborate, we find that an increase in foreigners' market share displays negative effects on yields at the medium and long segments of the yield curve, contrary to its positive effects at the short end. In terms of market concentration, the effects brought forth by foreign investors are dominated by the short end of the yield curve. To better characterize these agents, we compare our results with qualitative surveys conducted by the Central Bank of Colombia.

Literature Review: Perhaps the paper most closely related to ours is Ebeke and Kyobe (2015), which examines, for a group of 17 countries, the effects of foreign participation in different currency-denominated assets. Utilizing panel smooth threshold regressions, the authors find that higher foreign participation in local-currency bond markets increases the transmission of global financial shocks once foreign participation exceeds a threshold of 30%. To address endogeneity problems, they employ as instruments the two-quarter lags of foreign participation and use the predicted values of foreign holding ratios explained by the distance to financial centers (financial remoteness). Regarding the latter, we argue that recent technological changes can diminish the benefits of being in a specific geographical location (King et al., 2013). Our methodology differs in that we incorporate a maturity-investor dimension of bond holdings. More notably, we focus on the effects of *within* investor group market concentration, as opposed to their overall investor base concentration.

We also acknowledge recent studies on the Colombian case that examine the behavior of bond holdings around the 2014 J.P. Morgan Government Bond Index for Emerging Markets

[2]Examples include: Fidora et al. (2007), Peiris (2010), Tokuoka (2010), Beltran et al. (2013), Beltran et al. (2013), Ebeke and Lu (2015), Konopczak (2015), Ebeke and Kyobe (2015), Carvalho and Fidora (2015).

(GBI-EM) rebalancing episode. In this literature, Williams (2018) uses a difference-in-difference (DID) analysis to assess how government access to foreign credit impacts private loans. The author primarily focuses on asset and loan volume, revealing that market makers (in comparison to non-market makers) reduced their bond holdings by 7.8 p.p. and increased their loans by 4.2 p.p. during that episode. Garcia-Andrade (2019) also conducts a DID estimation, comparing Colombia with other countries included in the J.P. Morgan GBI index. The study finds a permanent reduction of up to 98 basis points in domestic 10-year sovereign bonds. Finally, Romero et al. (2020) present suggestive evidence that foreign inflows reduced government bond yields and increased loan supply.

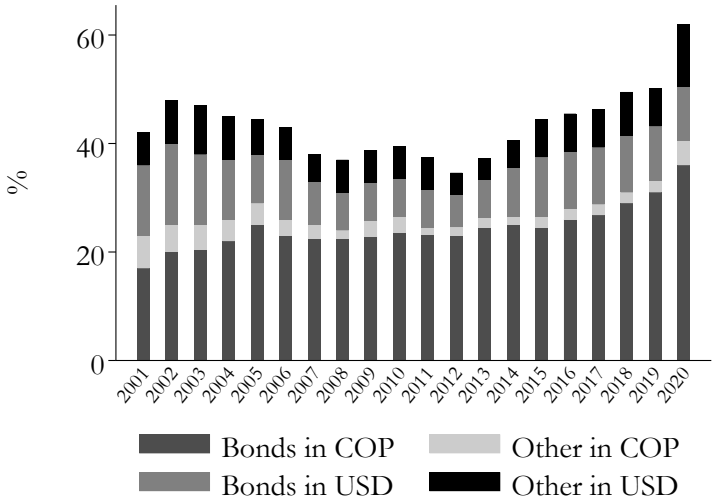
While we believe that our research largely complements these efforts, we additionally expand the analysis of the 2014 J.P. Morgan GBI-EM rebalancing episode on the effects of market shares and concentrations on both the level and volatility of bond yields. We find that under this shock, an increase in a one standard deviation in foreign investors' share led to a reduction of 0.2 p.p. in bond yields (3% relative to its mean) and a reduction of 0.06 p.p. in yield volatility (29% relative to its mean). Under this shock, foreign investors continued to act as catalysts, contributing to the reduction of both yields and yield volatility. However, this episode did not hold any significant effects resulting from changes in market concentrations.

Our paper proceeds as follows: Section 2 describes the Colombian context, including the evolution of investors' participation and concentration of sovereign bond holdings. It also details our data and data sources. Section 3 describes our methodology and results, including dynamic effects, and effects across maturities. Robustness checks controlling for demand-driven factors, using instrumental variables, and analyzing the J.P. Morgan GBI-EM rebalancing episode are included in Section 4. Finally, Section 5 concludes.

2 The Colombian Context

We recognize that the "*original sin*" problem is mostly related to the currency composition of sovereign debt. However, the post-graduation from the original sin (i.e. once a country is able to issue debt in domestic currency) brings about new issues related to the composition and structure of public debt. As shown in Figure 1, since the mid-2000s, the amount of sovereign debt in Colombia has been mostly denominated in domestic currency (COP). In 2020, total public debt amounted to $177 billion USD, roughly 65% of GDP. Of the total, 32% was in USD ($63 billion) and 65% in domestic currency ($114 billion).[3] Further, USD bonds represent only 17% of the total debt while COP bonds represent almost 60%.[4] In our data, we focus on domestic currency bond trades (and the resulting bond holdings) by investor type. Essentially, we center our attention on the holders' dynamics (market share and market concentration), which have exhibited significant variation over the past two decades.

Figure 1: Sovereign debt by currency composition (% of GDP)



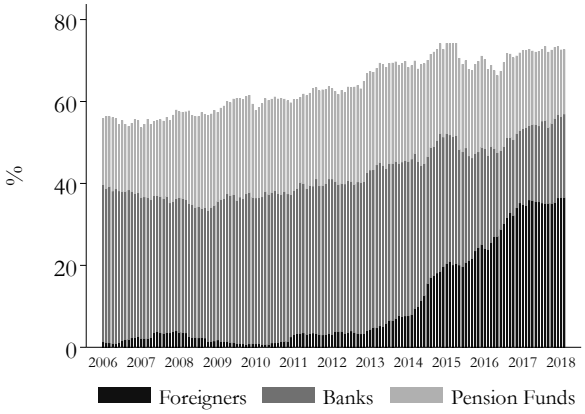
Note: The figure shows the total Colombian sovereign debt broken down by currency (COP and USD) and by type (bonds and other). Source: *Ministerio de Hacienda y Crédito Público.*

[3] 18% in inflation-adjusted bonds (*Unidad de Valor Real*) -UVR, and 46% in COP. The remaining 4% was denominated in euros.

[4] The non-deliverable forwards (NDFs) market for government bond holdings in domestic currency (TES-COP) is relatively small but growing. To date, most of this market is traded overseas, and between non-residents and the banking sector. In the year 2019, the total market turnover of NDFs amounted to 12% of GDP.

Figure 2 depicts the share of government bond holdings in domestic currency (TES-COP) of the three key investor groups in our research: foreigners (or non-residents), banks, and pension funds.[5] Pension funds hold approximately 20% of the total market, with relatively stable participation through time. Foreign investors on the other hand, sharply increased their market share from 3% before 2014 to over 35% in 2018. The main reason is that on March 19, 2014, the J.P. Morgan GBI-EM saw a large rebalancing of Colombia's weight participation, from 3.9% to 8.0%. This led to a surge in foreign demand for Colombian bonds, which affected the portfolio balance of the entire banking system. As such, banks sold bonds to foreigners reducing their bond market share, from 35% before 2014 to 20% in 2018.

Figure 2: Government bond holdings by investor group (% of total bond market)



Note: Authors' calculations. The figure shows the market share of the Colombian sovereign debt market (TES-COP) in the hands of the three largest investor groups: foreigners (non-residents), banks, and pension funds.

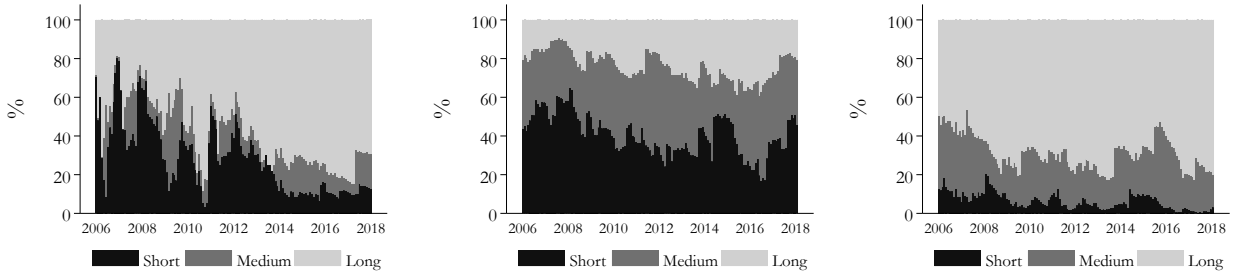
Figure 3 shows, for each of the three key investor groups, their bond holdings by maturity: short (1-2 years), medium (3-5 years), and long (over 5 years).[6] While domestic banks display stable favoritism over short and medium-term bonds, pension funds show a constant preference over long-term bonds. Foreign investors' holdings have been changing during the sample period; before 2014, they exhibited an inclination towards short-term bonds, while after 2014 they transitioned in favor of the long part of the yield curve.[7]

[5]These categories are defined by the Colombian Treasury (*Dirección General de Crédito Público y Tesoro Nacional*) following international definitions. While there are a total of 21 group categories, we focus on the largest three which represent almost 60% of the market.

[6]In addition, panel (a) of Figure A1 in Appendix A shows the bond market share broken down by investor group for each particular maturity, while panel (b) displays the total bond market size by maturity.

[7]Figure A2 in Appendix A presents the evolution of net purchases of the three key investor groups by

Figure 3: Government bond holdings by maturity



(a) Foreign investors (b) Banking sector (c) Pension funds

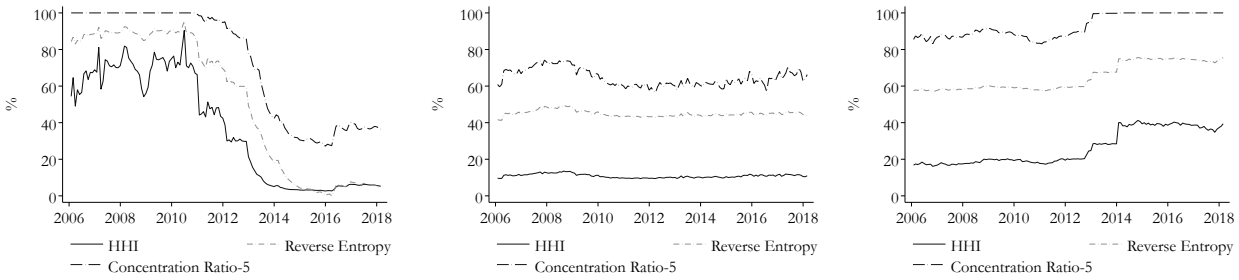
Note: Authors' calculations. The figure shows the share of the Colombian sovereign debt market (TES-COP) by short, medium, and long segments of the yield curve, held by foreign investors (% of total foreign holdings), banks (% of total domestic bank holdings), and pension funds (% of total domestic pension funds holdings).

Figure 4 shows the market concentration *within* each group. The measure of market concentration is scantly used in this strand of literature, and usually refers to the concentration *across* investor groups (Ebeke and Kyobe, 2015). We use the Herfindahl index (HHI) which exhibits very similar behavior to alternative measures of market concentration, such as the reverse entropy index or the CR-5 concentration ratio. The figure shows that, since 2010, foreign investors' market concentration declined, even while one investor (Franklin Templeton Investments) held a significant majority. Regarding pension funds, the increase in market concentration after 2012 was attributed to the fact that: (i) the fund *ING Administradora de Pensiones y Cesantias* ceased to hold bonds in 2012, (ii) the public-owned fund *Instituto de Seguros Sociales* was substituted by *Colpensiones* in 2012, and (iii) the fund *AFP Horizonte* was acquired by the fund *Porvenir* in 2013.

Figure 5 depicts the market concentrations *within* each of the key investor groups by maturity. While domestic banks' concentration is homogeneous across maturities (around 10%), pension funds display a higher concentration at the short end of the curve, over 75% in 2015 and 2018. Meanwhile, foreign investors' concentration transitioned from being higher in the long end before 2014, to being accentuated in the short end after 2014. Particularly, as presented in Figure A5 in Appendix A, foreign investors' market concentration after 2014 was mainly conducted by only two investors, while the rest of the non-residents were selling their shares.

maturity, showing the increasing purchases of foreign investors and pension funds in the long end of the curve, and the constant transactions of domestic banks in the short and medium segments.

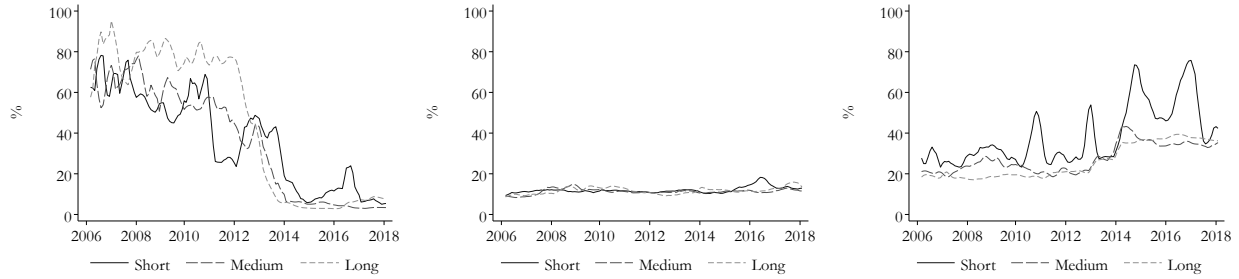
Figure 4: Herfindahl index and alternative measures of market concentration



(a) Foreign investors (b) Banking sector (c) Pension funds

Note: Authors' calculations. The figure shows three measures of market concentration within each investor group: the Herfindahl index, the reverse entropy index, and the CR-5 concentration ratio.

Figure 5: Herfindahl index by maturity



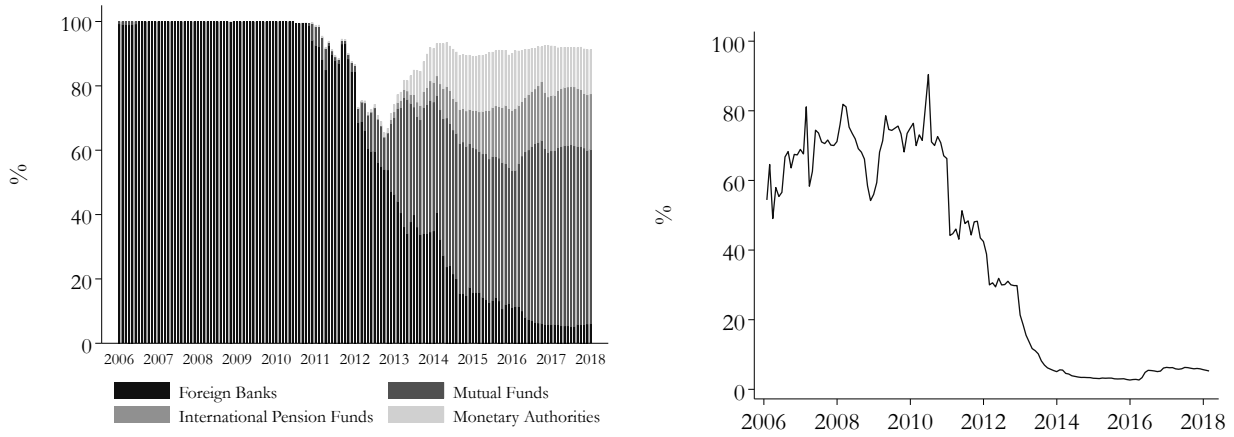
(a) Foreign investors (b) Banking sector (c) Pension funds

Note: Authors' calculations. The figure shows the Herfindahl index in the sovereign debt market (TES-COP) by short, medium, and long sections of the yield curve, for foreign investors, domestic banks, and domestic pension funds.

Finally, the Central Bank of Colombia classifies foreign investors in the TES-COP spot market into 10 groups,[8] based on the class of final costumers they respond to, and the investment approach they follow. As depicted in Figure 6, the four largest groups of foreign investors are: foreign banks, mutual funds, international pension funds, and monetary authorities. In particular, the reduction in non-residents' market concentration from the beginning of the 2010s was mainly induced by a progressive entrance of mutual funds, with a preference for long-term holdings, in a market that was previously concentrated by foreign banks, with favoritism for the short-term (see Figure A3 in Appendix A).

[8]Those are: endowment funds, foreign banks, hedge funds, insurance firms, monetary authorities, multilateral organizations, mutual funds, international pension funds, sovereign wealth funds, and non-classified.

Figure 6: Foreign investors market shares and concentration



(a) Foreign investors shares

(b) Foreign investors concentration

Note: Authors' calculations. Panel (a) shows the market share of the Colombian sovereign debt market (TES-COP) among foreign investors, in the hands of the four largest groups: foreign banks, mutual funds, monetary authorities, and international pension funds (% of total foreign holdings). Panel (b) shows the Herfindahl index within foreign investors.

Figures A3 to A6 in Appendix A present additional descriptives related with market shares and concentrations within foreign investors, displaying their different trends by maturity. In particular, panel (b) in Figure A5 presents the high concentration of non-residents among few, although stable, agents during the second half of the 2000s, while displaying a more variant composition during the 2010s.

2.1 Data

We observe data on the stock of peso-denominated sovereign bonds (TES) in the hands of each financial institution from the Central Securities Depository (DCV) which is managed by the Central Bank of Colombia.[9] The DCV records all sovereign bond trades carried out through two existing trading platforms: (i) the Colombian Electronic Market (MEC) administered by the Colombian stock exchange, and (ii) the Electronic Trading System (SEN) directly administered by the central bank.[10]

In the SEN platform, primary dealer banks carry out: cash or term purchase and sale

[9]We excluded inflation-adjusted bonds (*Unidad de Valor Real* -UVR) from our investigation, given their low liquidity and the fact that foreign investors held, on average, only 2% of the total market.

[10]To put things in perspective, the monthly average bond holding is $6.3 trillion ($6x10^{12}$) pesos. Also, third-party positions by intermediaries are almost three times greater than those of their own positions.

transactions, repurchasing agreements, simultaneous transactions, and securities transfers. Alternatively, in the MEC platform, all affiliated entities carry out operations, contracts, and own transactions on fixed-income securities registered in the National Registry of Securities and Intermediaries. Additionally, affiliates may register transactions between third parties not affiliated with the fixed-income securities system. The central bank performs inventories of net flows and updates the amount of TES in the possession of each entity. Among the information observed during the transaction is the "payment agent" from whom the resources must be debited, the "collection agent" to whom the resources are paid, the city, intermediary buyer, and seller (in case of transactions between third parties), currency, title name, term, rate, and nominal value to be transferred.

Our data initially contain close to 1.5 million observations, roughly 10,000 observations per month. From January 2006 until February 2018, we observe 181 intermediaries, and 35,587 bond holdings classified into 22 maturity groups. After aggregating individual bond holdings per maturity (1-9 years and $\geq$ 10 years) and per market group, we are left with roughly 1,500 observations.[11] Descriptive statistics are presented in Table 1. We focus our interest on market shares and concentrations for the three largest investor groups.

Table 1: Descriptive statistics for monthly aggregated data

	Obs	Mean	Std	Min	Max
Outcome Variables$^{(a)}$					
i	1,460	7.543	1.972	3.597	13.577
i Volatility	1,440	0.210	0.149	0.038	1.806
Investor Shares and Concentrations$^{(b)}$					
Foreign Share	1,460	7.260	12.556	0	55.672
Domestic Banks Share	1,460	21.826	18.455	0	87.877
Domestic Pension Share	1,460	20.088	19.459	0	74.655
Foreign HHI	1,460	35.267	39.723	0	100
Domestic Banks HHI	1,460	13.095	12.027	0	100
Domestic Pension HHI	1,460	27.771	23.032	0	100

Note: Authors' calculations. Data on government bond holdings (TES) are from the Central Securities Depository (DCV) at the Central Bank of Colombia.

[11]The reason why we include long-term maturities ($>$ 10 years) within the 10-year bracket is due to low turnover and liquidity.

3 Methodology and Results

3.1 Methodology

In the empirical estimations that follow, we employ a monthly panel dataset containing information on government bond holdings –by maturity– in the hands of foreign investors, banks, and pension funds from 2006 to 2018. We control for bond maturity fixed effects, time fixed effects, and for the market size and concentration of the main investor groups *within* each debt maturity.

We run panel OLS regressions in which our variables of interest ($X_{m,t-1}$) are the bond market shares and *within* concentrations for each of the three investor groups (foreign investors, domestic banks, and domestic pension funds). Our outcome variable $Y_{m,t}$ contains either the monthly bond yield for a given maturity ($i_{m,t}$) or its intra-month standard deviation ($\sigma_{m,t}$), obtained using a Dynamic Conditional Correlation (DCC) GARCH model. This methodology takes into account the fact that yields may be strongly correlated with other variables. Therefore, the calculation of yield volatilities contemplates the joint changes in the control variables used, (i) capturing the changing correlations between yields and additional variables, and (ii) considering the dynamic characteristics of correlations over time, giving a more accurate volatility measure. DCC-GARCH methodology is described in Appendix B, as well as the controls used in the estimation of yield volatility. Consequently, the regression model that we estimate is specified as follows:

$$Y_{m,t+h} = \alpha_m^h + \alpha_t^h + \theta^h X_{m,t-1} + \epsilon_{m,t+h}, \tag{1}$$

where α_m and α_t indicate maturity and time fixed-effects. As benchmark, we estimate results for $h = 0$. Additionally, following Jordà (2005) methodology of local projections, we examine dynamic effects by estimating sequential regressions in which yield levels and volatility are shifted forward each month (for $h = 0 - 11$ months).

To avoid artificial or mechanical outcomes stemming from mirroring investor groups (where one investor buys from another), we include all market shares and market concentrations in the same regression specification. Hence, the effect of one group is conditional on the market shares and concentrations of the other main groups.

3.2 Benchmark results

Our benchmark results are reported in Table 2, where rows 1-3 correspond to market shares (*across* investor groups) and rows 4-6 correspond to market concentrations (*within* investor groups). Our two dependent variables are bond yields (columns 1, 3, and 5) and bond yield volatility (columns 2, 4, and 6). We choose columns 1 and 2 as our benchmark since the specification controls for both market shares and concentrations, with maturity and time fixed effects. For ease of interpretation, we standardize market shares and concentrations so that an impulse shock corresponds to a one standard deviation.

Results show that a one standard deviation increase in foreigners' market share reduces bond yields and bond yield volatility. In particular, it reduces yields by 0.035 percentage points (p.p.) and yield volatility by 0.005 p.p. Relative to their mean values (7.5% for yields and 0.2% for volatility) they represent 0.5% and 2.5%, respectively. These results are somewhat different from those in Obstfeld (2012), Ebeke and Lu (2015), and Ebeke and Kyobe (2015) who find that, while higher foreign participation decreases yields, it also increases the sensitivity of overall portfolio flows to global financial conditions, which in turn increases yield volatility. In our case, foreign holdings of sovereign bonds reduce yields while at the same time dampening bond yield volatility. A potential reason is that foreign investors act as catalysts for the development of local bond markets by diversifying the institutional investor base and creating greater demand (and liquidity) for local debt securities. Also, according to Burger and Warnock (2004), foreign participation may stabilize markets by reducing currency mismatches and serving as an alternative source of funding.[12]

Regarding market concentration, we observe a negative effect on bond yields and yield volatility attributed to foreign investors. Specifically, a one standard deviation increase in non-residents' Herfindahl index decreases bond yields by 0.044 p.p. (0.6% relative to its mean value). At face value, this result is surprising, as one would expect similar effects but instead driven by a more competitive market. However, as we show in Section 3.2.1, the explanation lies in the type of investors. Initially, all foreign investors in Colombia were foreign banks, exhibiting stable demand despite their limited number. This changed after 2012 with the significant entrance of mutual funds, which took the lion's share among foreigners. Consequently, while the number of foreign investors grew, making the market less concentrated, the predominant strategy (common in mutual funds) was associated with short-

[12]Studies that only evaluate the impact on yields are mostly consistent with our findings. Examples include Andritzky (2012), Beltran et al., 2013, Zhang and Ananchotikul (2014), and Garcia-Andrade, 2019.

term return investments and quick withdrawals based on performance, which deteriorated the market.

The literature on the effects of market concentration is rather scant. Among the few, Ebeke and Kyobe (2015) find that a high concentration of the investor base (above a certain threshold) makes emerging market yields more sensitive to global financial shocks. There are, nonetheless, studies that evaluate market concentration on other bank, firm, or financial variables. Such is the case of de Haan and Poghosyan (2012) who find that concentrated markets have experienced higher volatility during the recent financial crisis. Also, Mihov and Naranjo (2017) find that firms with more concentrated customer bases have higher idiosyncratic volatility. From an optimal contracting framework, Bolton and Scharfstein (1996) and more recently Schumacher et al. (2020) show that a more concentrated creditor base can make debt restructuring more disruptive.

Table 2: Benchmark results – Panel OLS with fixed effects

	—Benchmark—					
	(1)	(2)	(3)	(4)	(5)	(6)
	i	i Volatility	i	i Volatility	i	i Volatility
Market Shares & Concentrations						
Foreign Share$_{t-1}$	-0.035**	-0.005*	-0.034***	-0.006**		
	(0.016)	(0.003)	(0.013)	(0.003)		
Domestic Banks Share$_{t-1}$	0.052***	0.014**	0.040***	0.013***		
	(0.016)	(0.007)	(0.014)	(0.004)		
Domestic Pension Funds Share$_{t-1}$	0.064***	0.013*	0.043***	0.015***		
	(0.017)	(0.007)	(0.013)	(0.005)		
Foreign HHI$_{t-1}$	-0.044**	0.004			0.003	0.015***
	(0.019)	(0.008)			(0.013)	(0.004)
Domestic Banks HHI$_{t-1}$	-0.015	0.009			-0.013	0.009
	(0.013)	(0.006)			(0.014)	(0.006)
Domestic Pension Funds HHI$_{t-1}$	0.007	-0.010			0.035**	-0.002
	(0.023)	(0.007)			(0.016)	(0.004)
Maturity FE	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓
Observations	1,450	1,440	1,450	1,440	1,450	1,440

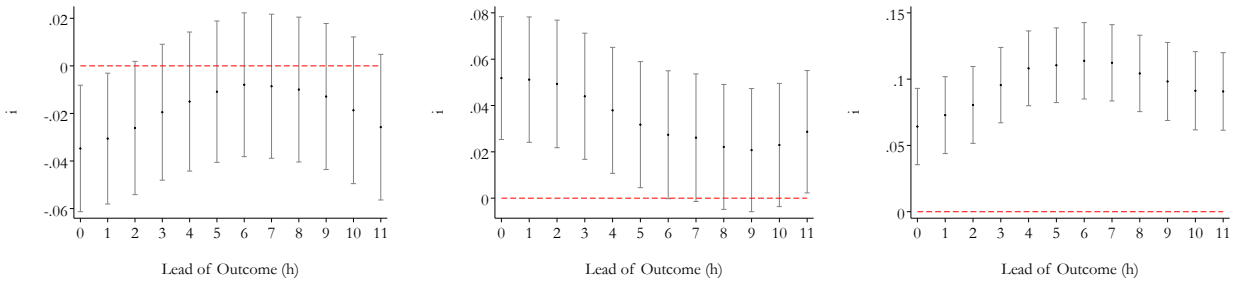
Note: Authors' calculations. Dependent variables include the monthly bond yield (i) and the intra-month bond yield standard deviation (i Volatility). Market shares and concentrations are standardized so that an impulse shock corresponds to one standard deviation. Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent level, respectively.

Concerning the banking sector and pension funds, we find an opposite effect on yields and yield volatility: a one standard deviation increase in their market share increases yields by 0.052 p.p. (0.7% relative to its mean value) and 0.064 p.p. (0.8% relative to its mean value), as well as yield volatility by 0.014 p.p. and 0.013 p.p. (7% and 6% relative to the mean value), respectively. We do not find significant effects for their market concentrations.

We next evaluate dynamic effects by estimating local projections, as exemplified in equation (1). Results are reported in Figures 7 to 10, as well as in Table D2 in Appendix D, corresponding to an increase in one standard deviation in either market shares or concentrations. Results show again negative effects of foreign investors' share and concentration on yields and yield volatility, while presenting positive effects of domestic banks and domestic pension funds shares on both yields and volatility.

In particular, Figures 7 and 8 show negative effects of foreign investors' share, reducing bond yields during the first months, and yield volatility by up to 0.02 p.p. (10% relative to the mean) during the first year. Contrarily, both domestic banks and pension funds shares display positive dynamic effects on yields. Particularly, they induce an increase by up to 0.05 p.p. (0.7% relative to the mean) and 0.1 p.p. (1.3% relative to the mean), respectively. Similarly, banks' share increases volatility by up to 0.02 p.p.

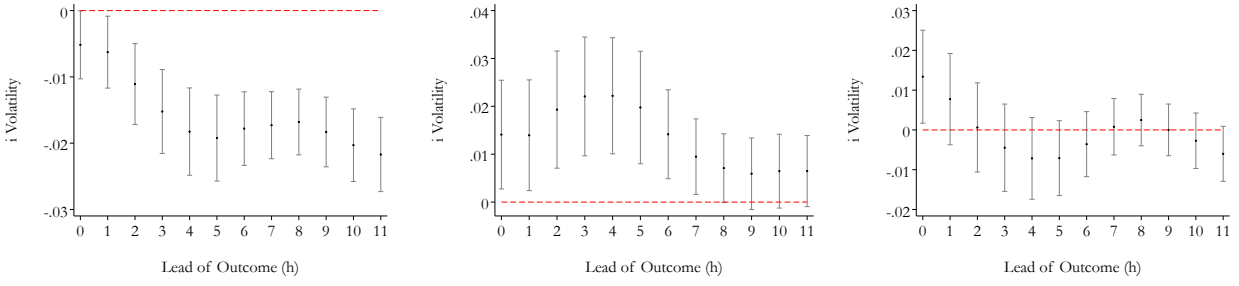
Figure 7: IRF Figures - i vs Market shares



(a) Foreign investors (b) Banking sector (c) Pension funds

Note: Authors' calculations. The Figure shows coefficients of Columns 1, 3, and 5 presented in Panel A of Table D2, with robust confidence intervals significant at a 10 percent level.

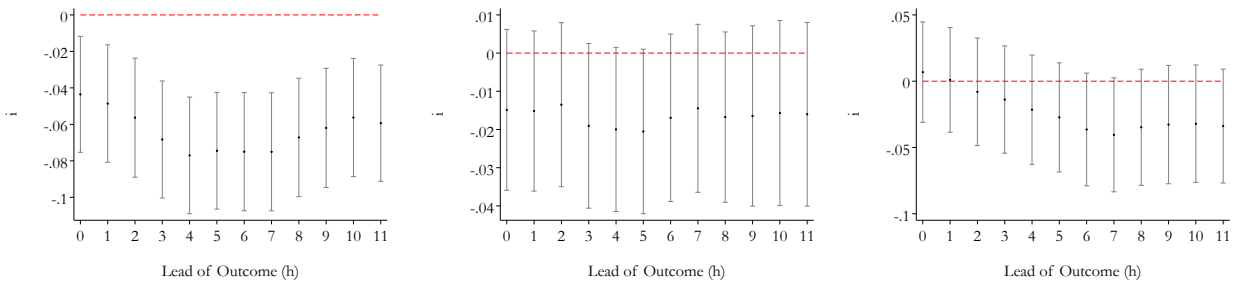
Figure 8: IRF Figures - i Volatility vs Market shares



(a) Foreign investors (b) Banking sector (c) Pension funds

Note: Authors' calculations. The Figure shows coefficients of Columns 2, 4, and 6 presented in Panel A of Table D2, with robust confidence intervals significant at a 10 percent level.

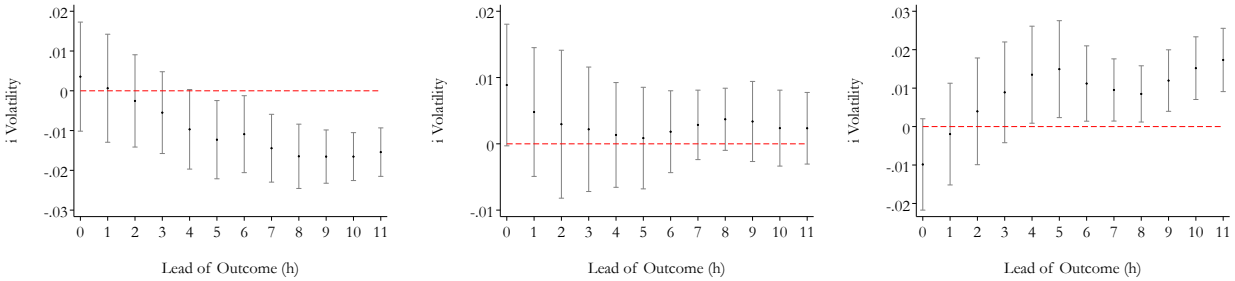
Figure 9: IRF Figures - i vs Market concentrations



(a) Foreign investors (b) Banking sector (c) Pension funds

Note: Authors' calculations. The Figure shows coefficients of Columns 1, 3, and 5 presented in Panel B of Table D2, with robust confidence intervals significant at a 10 percent level.

Figure 10: IRF Figures - i Volatility vs Market concentrations



(a) Foreign investors (b) Banking sector (c) Pension funds

Note: Authors' calculations. The Figure shows coefficients of Columns 2, 4, and 6 presented in Panel B of Table D2, with robust confidence intervals significant at a 10 percent level.

Along the same line, Figure 9 shows that foreign investors' market concentration has a negative effect on bond yields and yield volatility: up to 0.08 p.p. (1.1% relative to the mean) on yields, and 0.02 p.p. (10% relative to the mean) on volatility. Figures 9 and 10 show that market concentration does not affect yields nor yield volatility for the banking sector or pension funds.

Overall, dynamic effects align with the results presented in Table 2. While foreigners act as market catalysts, reducing both yields and yield volatility through their share and concentration, domestic banks and pension funds shares have incremental effects on yields and their volatility.

3.2.1 Heterogeneous effects across maturities

We next examine differential effects across segments of the yield curve. For this, we expand our local projections model with maturity and time fixed effects presented in equation (1) to include interactions with dummy variables for medium and long-term maturities. This allows us to decompose the benchmark effects for each section of the curve.[13] Results are presented in Figures 11 to 14, as well as in Table D3 in Appendix D for the first lead, corresponding to an increase in one standard deviation in either market shares or concentrations.

In particular, our benchmark effects are mainly driven by the medium and long segments of the curve, since they explain 30% and 50% of our data, respectively. Overall, we find that non-residents' market share has a positive effect on yields and volatility at the short end of the curve, and a negative effect at the medium and long sections. Moreover, an increase in foreigners' market concentration strongly reduces short-term yields and volatility.

Market shares. Figure 11 shows that foreign investors' share presents a positive effect on yields at the short end of the curve, and negative and small effects in the medium segment. In particular, they induce an increase by up to 0.6 p.p. (8% relative to the mean) in the short end, and they reduce yields by up to 0.04 p.p. (0.5% relative to the mean) in the medium section. In terms of yield volatility, Figure 12 shows that the share of foreign investors has positive effects in the short end, while presenting negative effects in both the medium and long segments: increasing up to 0.05 p.p. (24% relative to the mean) in the short end, and reducing up to 0.02 p.p. in the medium and long sections.

These results can be explained by non-residents' different preferences across maturities. As presented in Figure 3, and as reported in surveys conducted by the Central Bank of Colombia depicted in Appendix C, determinants guiding foreign investors differ by segment of the curve. In particular, foreign investment decisions in the short end are associated with factors such as the local stance of monetary policy and short-term interest rates, or even with speculative reasons that can provoke increases in yields and yield volatility. This contrasts with investors identified with medium and long-term investment strategies, which consider factors such as fiscal and external vulnerabilities, long-term yield spreads (relative to advanced economies), and the overall term structure, pushing foreign investors' preferences towards longer maturities, and inducing reductions in both yields and volatility.

[13] Recall that we define short-term maturities between 1-2 years, medium-term between 3-5 years, and long-term over 5 years.

In the case of domestic banks, market shares present negative effects on yields in the short end, and positive effects in the medium and long segments: up to 0.15 p.p. reduction (2% relative to the mean) in the short end, and an increase close to 0.1 p.p (1.3% relative to the mean) in the middle and long sections. In contrast, the market share of pension funds has positive effects on yields for all segments of the curve, with a particularly strong effect in the short end, by up to 0.4 p.p. (5.3% relative to the mean), and smaller effects in the medium and long segments (0.2 p.p. and 0.1 p.p.).

Concerning yield volatility, the banking sector share presents a positive effect in volatility by up to 0.04 p.p. (19% relative to the mean) in the medium segment, but no significant effects in the short and long ends. Meanwhile, the market share of pension funds displays a negative effect on volatility in the short end by up to 0.07 p.p., but no significant effects in the medium and long segments.

Market concentration. Regarding market concentration effects on yields (Figure 13), an increase in foreign investors concentration presents negative effects in the short and long ends, by up to 0.4 p.p. (5.3% relative to the mean) and 0.07 p.p., respectively, but no significant effects on the medium segment. At the same time, foreign investors' concentration reduces volatility in the short and medium segments of the curve, by up to 0.05 p.p. and 0.02 p.p. (24% and 10% relative to the mean), respectively, with no particular significant effects in the long end.

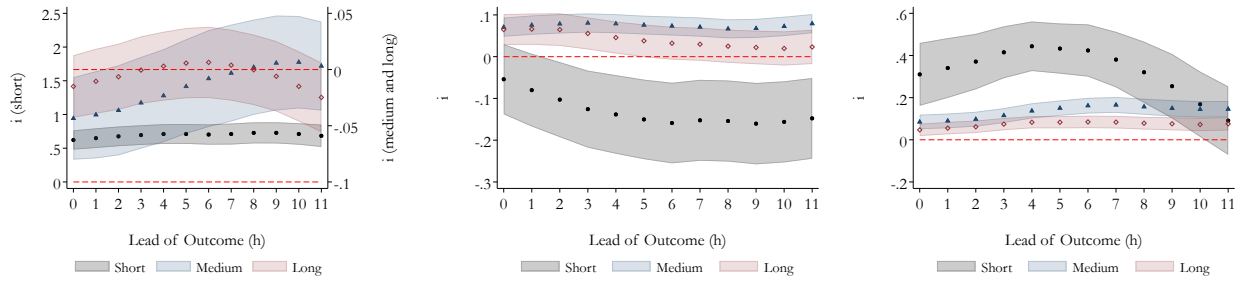
As presented in Figure 6, the reduction of foreign investors concentration since the beginning of the 2010s was induced by an important entrance of mutual funds into the Colombian sovereign debt market, which was previously concentrated by foreign banks. Now, the behavior of mutual funds can be related to higher liquidity risks, due to the final customers these groups respond to. Mutual funds are associated with short-term return strategies when they face capital constraints and redemption pressures based on their performance. As retail investors constitute their funds, they are vulnerable to frequent and sometimes unexpected withdrawals, pushing investors into frequent and pro-cyclical trading activity. This is, they sell (buy) bonds when securities start depreciating (appreciating) (Timmer, 2018; Hui, 2019; Fong et al., 2022).

In this line, Bertaut et al. (2023) show that mutual funds exhibit the greatest selling response to internal and external factors among foreign investors. This behavior is further accentuated in less liquid markets, such as Colombia, exacerbating the price reaction of local bonds. For instance, Franklin Templeton, a mutual fund that held most of foreign

investors' holdings in 2019, suddenly reduced its share by half due to internal investment decisions.[14]

Contrarily, foreign investors with less exposure to liquidity needs, such as foreign banks, are able to apply buy-and-hold trading strategies without inducing unexpected withdrawals. As depicted in Figure A6 in Appendix A, foreign banks present much more stable participation in negotiations within the TES-COP market than mutual funds, with a particular preference for short-term holdings in the second half of the 2000s, as presented in Figure A3. Therefore, the higher concentration within foreign investors was led by investors with a stable investment strategy, and was progressively reduced by the entrance of more unstable holders, leading to an increase in yields and volatility.

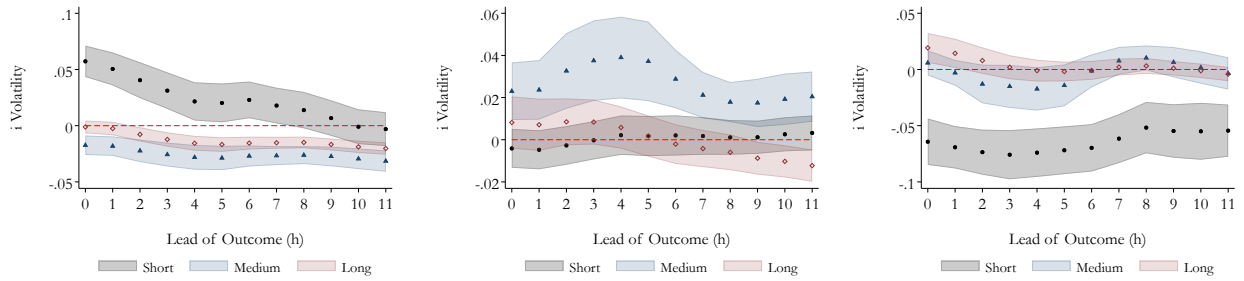
Figure 11: IRF Figures - i vs Market shares by maturity



(a) Foreign investors (b) Banking sector (c) Pension funds

Note: Authors' calculations using robust confidence intervals significant at a 10 percent level.

Figure 12: IRF Figures - i Volatility vs Market shares by maturity

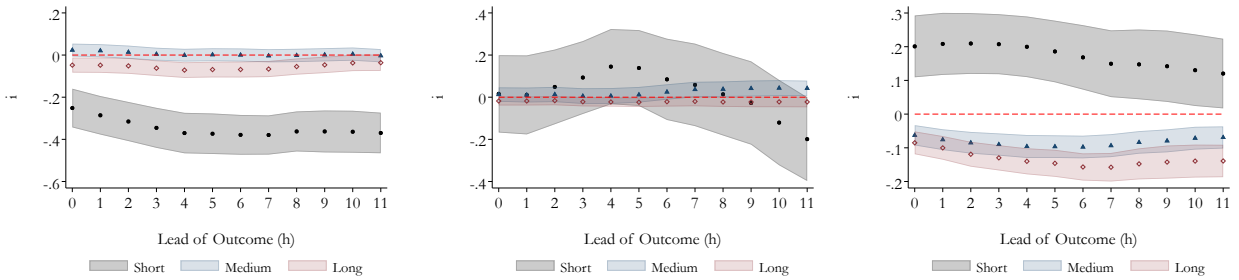


(a) Foreign investors (b) Banking sector (c) Pension funds

Note: Authors' calculations using robust confidence intervals significant at a 10 percent level.

[14]"Most of this sale was conducted by Michael Hasenstab (vice president and chief investment officer of Franklin Templeton), who gained widespread recognition by engaging in substantial and ultimately highly lucrative betting activities in countries facing difficulties after the financial crisis." Portafolio (2019).

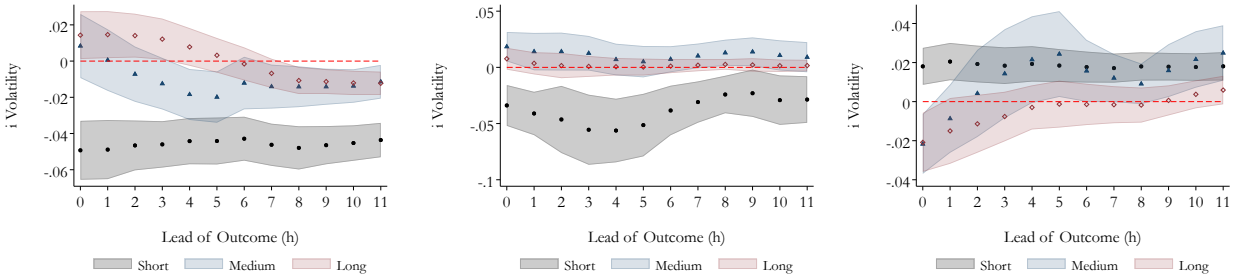
Figure 13: IRF Figures - i vs Market concentrations by maturity



(a) Foreign investors (b) Banking sector (c) Pension funds

Note: Authors' calculations using robust confidence intervals significant at a 10 percent level.

Figure 14: IRF Figures - i Volatility vs Market concentrations by maturity



(a) Foreign investors (b) Banking sector (c) Pension funds

Note: Authors' calculations using robust confidence intervals significant at a 10 percent level.

Table D9 and Figures D8 to D11 in Appendix D expand these exercises by incorporating *within* concentrations for foreign banks and mutual funds. We observe positive effects on yields from mutual funds' concentration, particularly in the short end, while foreign banks' concentration negatively affects yields and volatility. These findings provide additional evidence that while the higher concentration of non-residents was initially influenced by a stable, although reduced, number of foreign banks catalyzing the market, increases in mutual funds concentration can be detrimental due to their short-term speculative strategies.

Both yields and yield volatility in the Colombian bond market exhibit heterogeneous effects across market shares and concentrations of investors, but these differences also extend across segments of the yield curve. This reflects the preferences of foreign and domestic investors for different maturities, and highlights their influences over the short, medium, and long sections of the curve. For robustness, Table D4 in Appendix D presents regressions omitting each maturity at a time, and Tables D5 to D8 display results for longer and shorter maturity outcomes. Results show that no particular maturity is guiding the effects.

4 Robustness checks

4.1 Instrumental variable approach

One concern is that debt holdings (and prices) might be subject to a simultaneity bias. For instance, foreign investors might react and divert resources from volatile markets, but can also induce market volatility when investing or withdrawing funds. Also, long-term interest rates can be influenced by unobserved variables related to market expectations, resulting in an omitted variable bias (Wu, 2006; Beltran et al., 2013). To address these endogeneity concerns, we next undertake an instrumented variable (IV) approach.

We consider two types of instruments. Similar to Ebeke and Lu (2015) and Ebeke and Kyobe (2015), the first type of instruments are the two-quarter lags of market shares and concentrations. As a second type, we use the one-step system GMM estimation, developed in Arellano and Bover (1995). This estimation better exploits information by using a larger set of instruments, which in our case are the differences and up to 2 lags of all explanatory variables and treatments. This allows us to correctly estimate endogenous dynamic panel estimators, under the assumption that the lags and first differences of the explanatory variables are uncorrelated with the fixed effects and error term.

Table 3: Effects using Instrumental Variables

	Benchmark		IV 2M Lags		Arellano-Bover	
	(1)	(2)	(3)	(4)	(5)	(6)
	i	i Volatility	i	i Volatility	i	i Volatility
Market Shares & Concentrations						
Foreign Share$_{t-1}$	-0.035**	-0.005*	-0.032	-0.005	-0.033*	-0.008***
	(0.016)	(0.003)	(0.022)	(0.003)	(0.017)	(0.003)
Domestic Banks Share$_{t-1}$	0.052***	0.014**	0.065***	0.018**	0.047***	0.015**
	(0.016)	(0.007)	(0.019)	(0.008)	(0.012)	(0.007)
Domestic Pension Funds Share$_{t-1}$	0.064***	0.013*	0.090***	0.010	0.068***	0.009
	(0.017)	(0.007)	(0.026)	(0.009)	(0.019)	(0.007)
Foreign HHI$_{t-1}$	-0.044**	0.004	-0.070***	-0.000	-0.042**	0.011
	(0.019)	(0.008)	(0.025)	(0.010)	(0.017)	(0.007)
Domestic Banks HHI$_{t-1}$	-0.015	0.009	-0.013	0.007	-0.015	0.007
	(0.013)	(0.006)	(0.023)	(0.010)	(0.011)	(0.006)
Domestic Pension Funds HHI$_{t-1}$	0.007	-0.010	-0.008	-0.007	0.009	-0.006
	(0.023)	(0.007)	(0.047)	(0.012)	(0.027)	(0.007)
Maturity FE	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓
Observations	1,450	1,440	1,430	1,430	1,450	1,440

Note: Authors' calculations. Dependent variables include the monthly bond yield (i) and bond yield volatility (i Volatility). Market shares and concentrations are standardized so that an impulse shock corresponds to one standard deviation. Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent level, respectively.

Results are reported in Table 3. Columns 1 and 2 report our benchmark results, Columns 3 and 4 report results instrumented with the two-quarter lags of market participation and concentration, and Columns 5 and 6 report results instrumented with the one-step system GMM estimation. As observed, results with IV are very similar to our benchmark case, suggesting a low concern for endogeneity. In Table D10 of the Appendix D we report the first-stage estimates. Variables in each column (instruments for the different investor types) are regressed against their two-quarter lags. We report each F-test and p-value, all of which suggest a strong relevance of our instruments.

4.2 JP Morgan shock

Finally, we assess how changes in market shares and concentrations induced by one specific random shock affected both bond yields and yield volatility. In particular, in March 2014, J.P. Morgan decided to re-balance its Government Bond Index for Emerging Markets (GBI-EM), in which numerous Colombian treasury bonds were included. As documented by Williams (2018) and Garcia-Andrade (2019), the timing around this settlement is not only exogenous but also induced important adjustments in the portfolios of various agents. However, little has been studied about its effect on yields and yield volatility through changes in market shares and concentrations of bondholders.

Some of the main sources of information for investors are the indexes developed by credit rating agencies. In particular, the GBI-EM is an index managed by J.P. Morgan, which reflects the market capitalization of local currency sovereign debt for emerging countries. Thus, the index is constructed by weighting the returns of different assets chosen for each country, in this case, sovereign debt.[15] On March 19, 2014, J.P. Morgan announced the inclusion of bonds with maturities of 2, 4, 8, 10, and 14 years in the Colombian index, through a process that lasted between May and September of the same year. Nevertheless, the decision behind this announcement was not influenced by causes directly related to the country's economic situation, which was experiencing a period marked by various macroeconomic events.[16] Therefore, the announcement led to an increase in Colombia's GBI-EM by approximately 5 p.p., rising from around 3% to almost 8%.

[15]More details about the GBI-EM index and the J.P. Morgan shock are documented by Williams (2018).

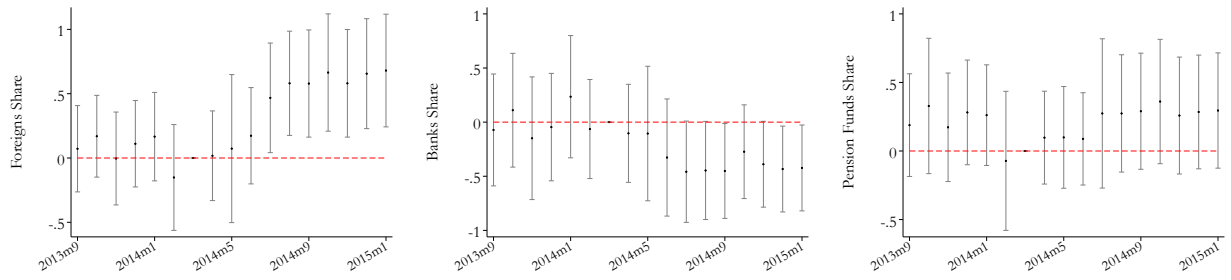
[16]The statement issued by J.P. Morgan confirms that this decision was not associated with any specific event: "As a result of improved transparency and accessibility for international investors in the local TES market, Colombia sufficiently meets inclusion requirements for complete GBI-EM inclusion."

To examine the effects of this rebalance in both market shares and concentrations, and the pass-through to yields and yields volatility, we undertake two different exercises. First, we estimate the following specifications

$$X_{m,t,k} = \alpha_m + \gamma X_{m,t-1,-k} + \sum_{t=2006m1}^{2014m2} \vartheta_t \alpha_t + \sum_{t=2014m4}^{2018m2} \theta_t \alpha_t + \nu_{m,t,k} \tag{2}$$

where X includes both market shares and concentrations of foreign investors, domestic banks, and pension funds, and α_m and α_t are maturity and time dummies, respectively. This way, coefficients θ_t capture the effects of the shock in each investor group share and concentration, while controlling by the rest of the market shares and concentrations.[17]

Figure 15: J.P. Morgan shock on market shares



(a) Foreigns share (b) Banks share (c) Pension funds share

Note: Authors' calculations. The Figure shows coefficients from the regression are presented in (2), with robust confidence intervals significant at a 10 percent level.

As depicted in Figure 15, and similar to Williams (2018), we find that the J.P. Morgan shock had an important effect on market shares. Particularly, it increased foreign investors' share by up to 0.8 standard deviations (10 p.p. with a mean value of 7.26%), while reducing banks' share by up to 0.7 standard deviations (13 p.p. with a mean value of 21.83%). We don't find significant effects in pension funds shares and, as presented in Figure D12 in Appendix D, we don't find significant effects of this shock on market concentrations.

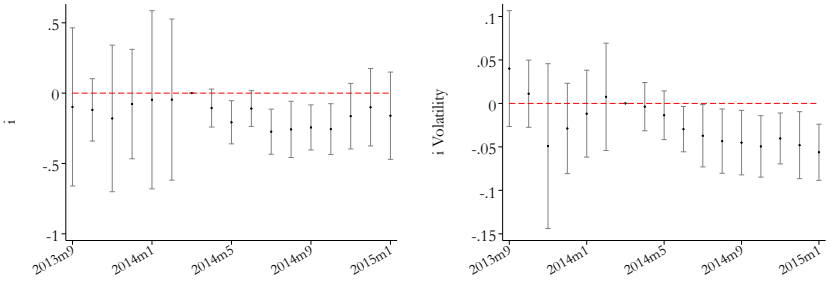
Next, we explore the pass-through of these effects on bond yields and yield volatility. For this, we estimate the following specifications:

$$Y_{m,t} = \alpha_m + \alpha_t + \gamma \hat{X}_{m,t-1} + \sum_{t=2006m1}^{2014m2} \varphi_t \hat{X}_{m,t-1} \times \alpha_t + \sum_{t=2014m4}^{2018m2} \phi_t \hat{X}_{m,t-1} \times \alpha_t + u_{m,t} \tag{3}$$

[17] $K = \{\text{Foreign Share}, \text{Banks Share}, \text{Pension Share}, \text{Foreign HHI}, \text{Banks HHI}, \text{Pension HHI}\}$, where $-k = K \setminus \{k\}$ for a $k \in K$.

where $\hat{X}$ includes each investor's group market shares and concentrations estimated in equation (2). Coefficients ϕ_t capture the pass-trough of the shock in yields and yield volatility produced by a one standard deviation increase on each group share.[18]

Figure 16: J.P. Morgan shock through foreign investors shares



(a) Yields (b) Yield volatility

Note: Authors' calculations. The figure shows interaction coefficients from the regression presented in equation (3), with robust confidence intervals significant at a 10 percent level.

Panel (a) in Figure 16 shows that under the J.P. Morgan shock, an increase in one standard deviation in foreign investors' share induced a reduction by up to 0.2 p.p. (3% relative to the mean) on bond yields. Similarly, as presented in panel (b), under this shock an increase in foreign investors' share reduced by up to 0.06 p.p. (29% relative to the mean) bonds yield volatility. We don't find significant results for the case of banks and pension funds shares, as depicted in Figures D13 and D14 in Appendix D.

Under the J.P. Morgan re-balance, results are consistent with those presented in Section 3, showing that foreign investors act like market catalysts when their market share increases, reducing both yields and yield volatility in the Colombian sovereign bond market.

[18]We focus on market shares since, as presented in Figure D12 in Appendix D, we find that the J.P. Morgan shock didn't affect market concentrations.

5 Concluding Remarks

The existing literature that empirically estimates the effects of foreign participation in sovereign bond markets is still divided. To some, foreign participation in local currency markets is associated with increased sensitivity of overall portfolio flows to global financial conditions. To others, foreign investors act as catalysts for the development of local bond markets by diversifying the institutional investor base and creating greater demand for local debt securities.

This study contributes to the debate by investigating the impact of government bond market participation and concentration in Colombia from 2006 to 2018 on bond yields. Our findings indicate that an increase in the share of foreign investors reduces yields and yield volatility, underscoring the benefits of active foreign participation in local bond markets. This proves advantageous for government financing costs and renders the bond market less susceptible to financial shocks.

Regarding market concentration, we observe a negative effect on bond yields and yield volatility attributed to foreign investors (with no significant effects found for either banks or pension funds) and argue that this effect is due to the type and mix of foreign investors. Initially, all foreign investors in Colombia were foreign banks, exhibiting stable demand despite their limited number. This later changed with the entrance of mutual funds, which took the lion's share among foreigners. Consequently, while the number of foreign investors grew, making the market less concentrated, the predominant strategy (common in mutual funds) was associated with short-term returns in investments and quick reversals based on performance, which deteriorated market stability.

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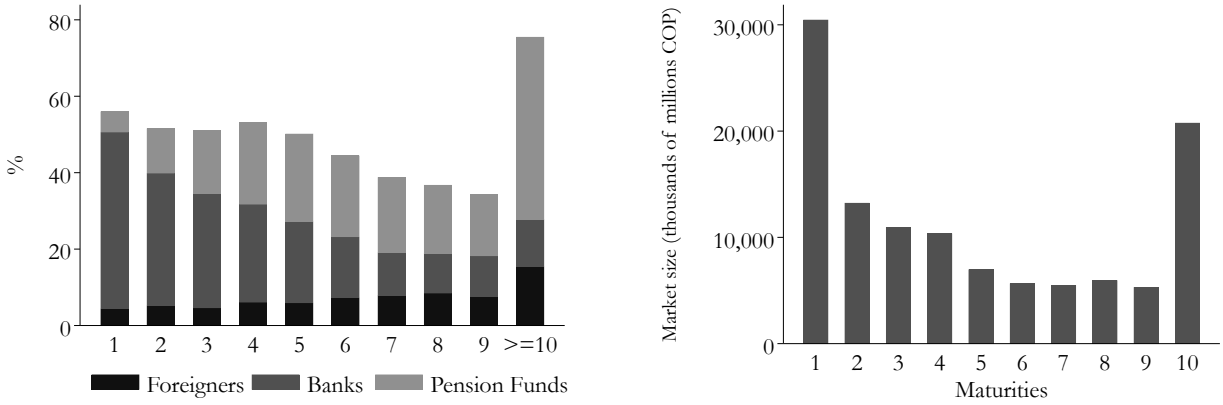
Appendix A Additional Descriptives

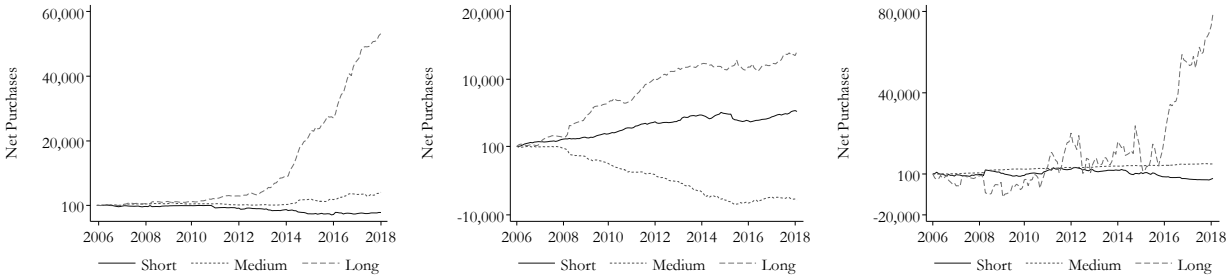
Figure A1: Government bond holdings by investor group and maturity



(a) Share by maturity (b) Market size

Note: Authors' calculations. Panel (a) shows sovereign bond market participation (%) by maturity bracket (1-9 years and ≥10 years) and investor group. Panel (b) shows the total market size ($COP 10^9) by maturity.

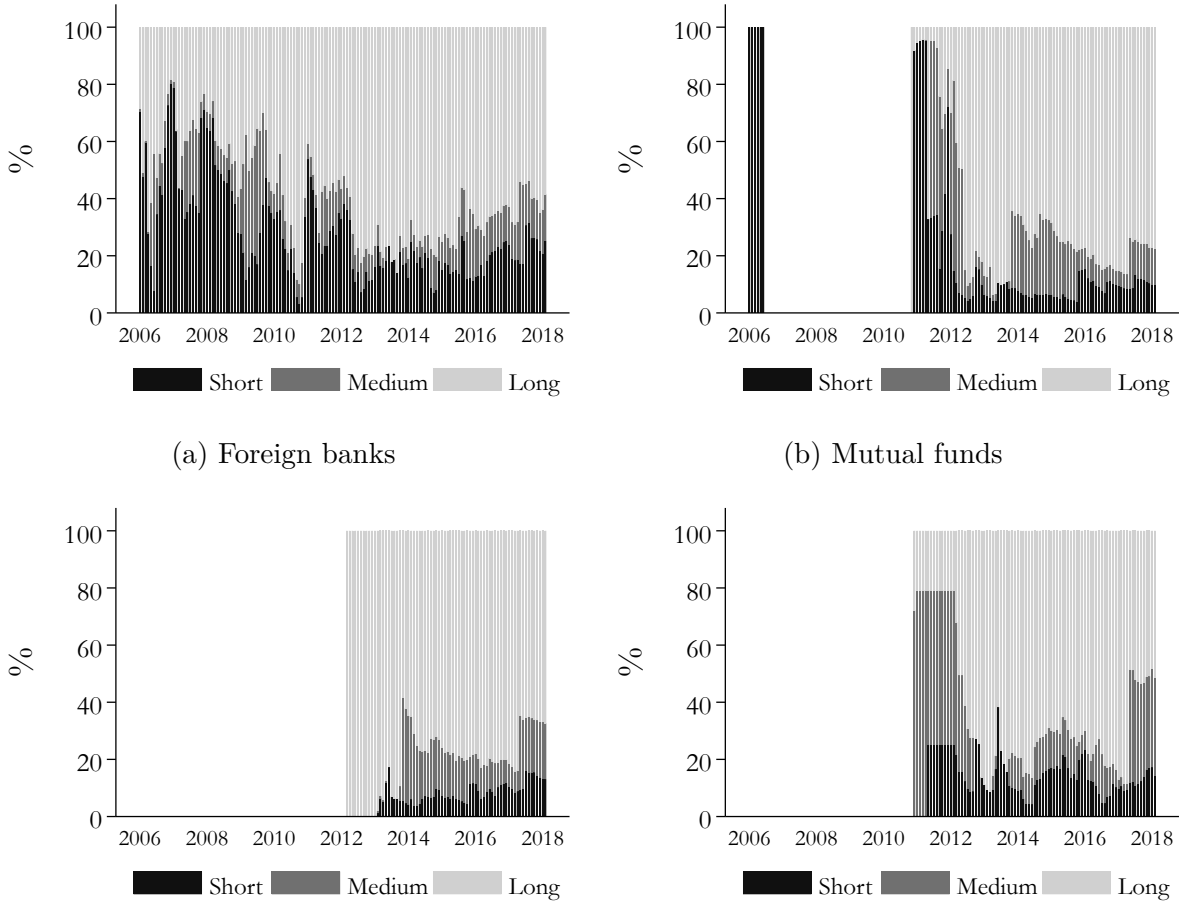
Figure A2: Investors net purchases by maturity



(a) Foreign investors (b) Banking sector (c) Pension funds

Note: Authors' calculations. The figure shows the net accumulated purchases of bonds in the Colombian sovereign debt market (TES-COP) made by foreign investors, domestic banks, and domestic pension funds, scaling January 2006 to 100. The dark line corresponds to the short end, while the dashed and long-dashed lines correspond to the medium and long sections of the yield curve, respectively.

Figure A3: Market shares within foreign investors by maturity



(a) Foreign banks

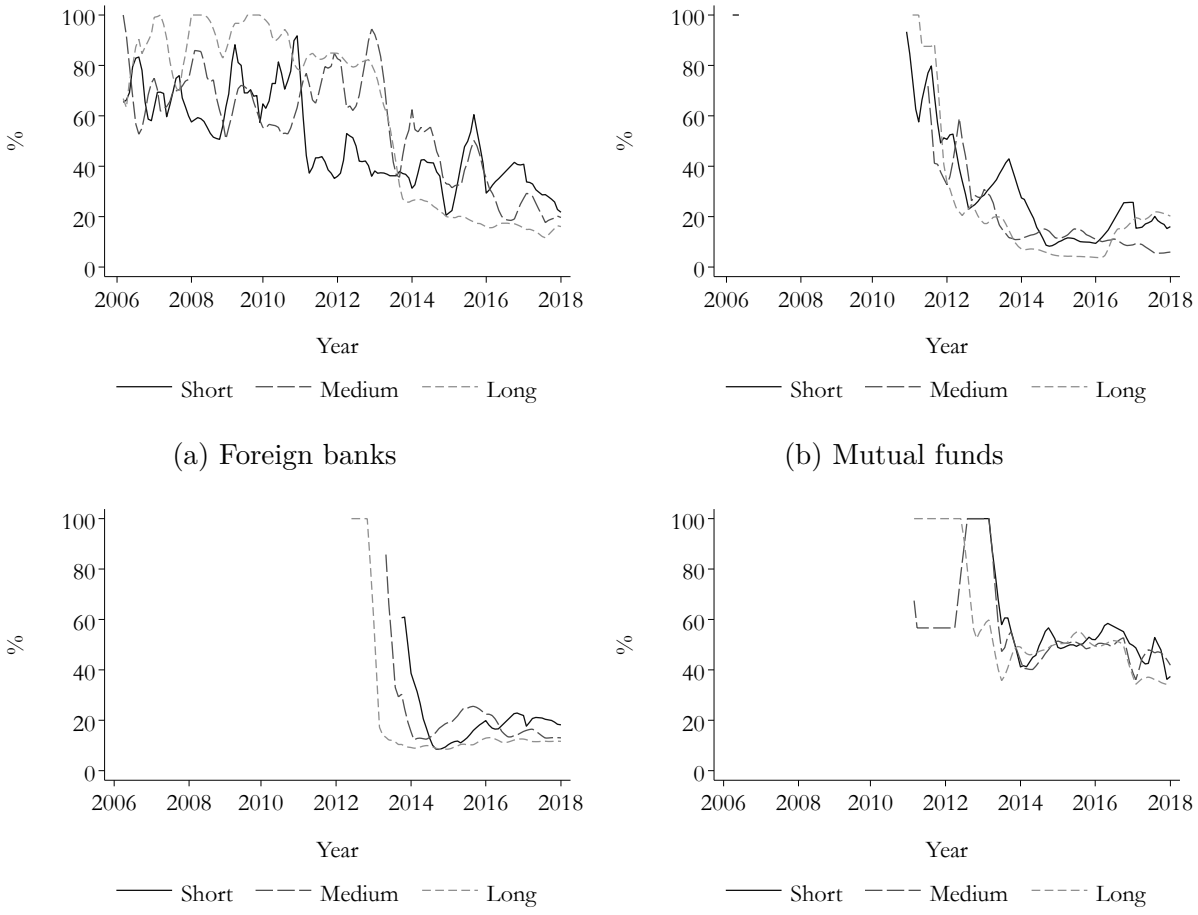
(b) Mutual funds

(c) International pension funds

(d) Monetary authorities

Note: Authors' calculations. The figure presents the market shares of the largest foreign investors by maturity.

Figure A4: Market concentration within foreign investors by maturity



(a) Foreign banks

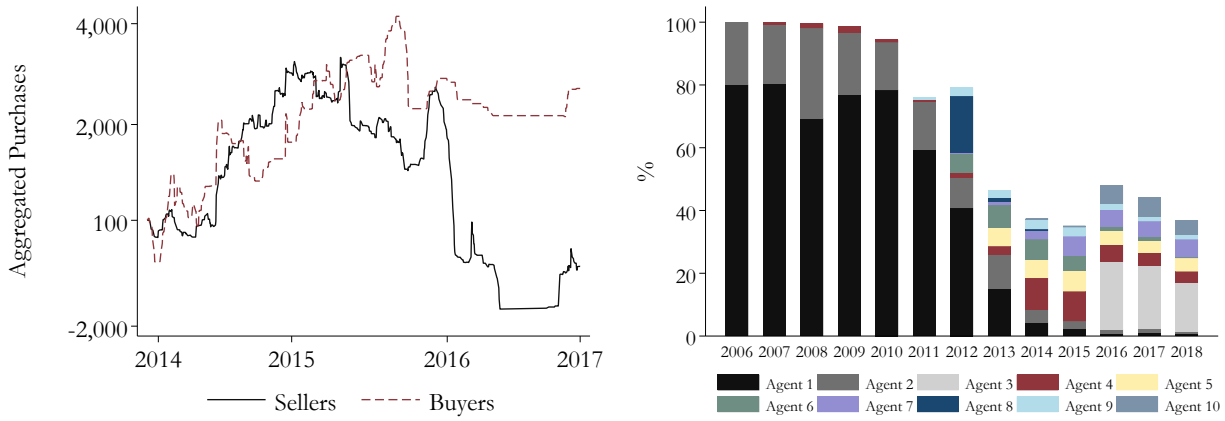
(b) Mutual funds

(c) International pension funds

(d) Monetary authorities

Note: Authors' calculations. The figure presents the Herfindahl Index of the largest foreign investors within the total of foreigners. The black line corresponds to the concentration in the short end, the black long-dashed line to the concentration in the medium section, and the long-dashed grey line to the concentration in the long end.

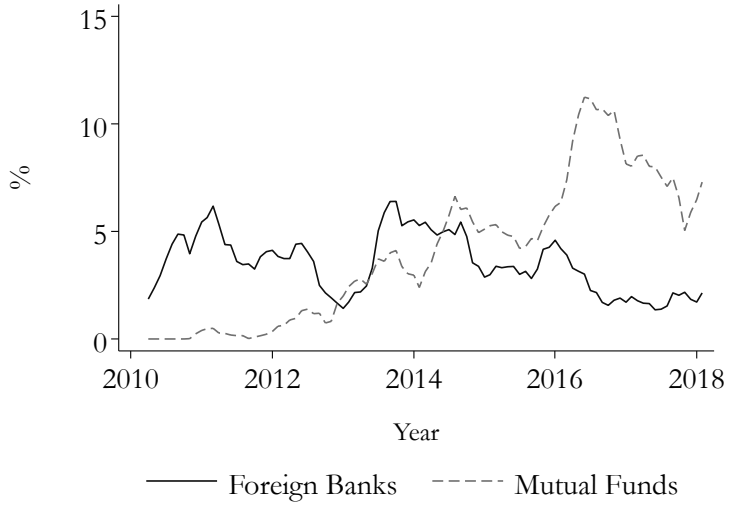
Figure A5: Market concentration within foreign investors



(a) Short end foreign investors purchases (b) Biggest foreign investors shares

Note: Authors' calculations. Panel (a) shows the aggregated purchases of foreign investors in the short end of the yield curve, scaling January 2014 to 100. The red dashed line corresponds to the only two foreign investors that bought short-term bonds after 2015, while the dark line corresponds to the rest of the foreign investors. Panel (b) shows the share of the ten biggest foreign investors within the total of foreign investors.

Figure A6: Foreign banks and mutual funds share relative to market negotiations



Note: Authors' calculations. The figure shows the monthly average share of foreign banks and mutual funds relative to the total negotiations within the TES-COP market.

Appendix B DCC GARCH Methodology

To estimate the intra-month standard deviation used in equation 1, we use the Dynamic Conditional Correlation (DCC) GARCH, firstly introduced by Engle III and Sheppard (2001). This multivariate GARCH model is useful to model the codependence and comovements between series (Orskaug (2009). Particularly, the DCC-GARCH model lets us extract the dynamic correlation between the control variables and the yields, resulting in a more precise individual volatility estimation, given that it separates the conditional volatility of each series from the conditional correlation matrix.

As in a usual GARCH model, the DCC-GARCH uses a mean conditional process and a function for the vector of mean-corrected errors. Given that there are some potential endogenous relationships between our variables, we employ a VAR(P) model to estimate the following mean equation

$$y_t = A_0 + \sum_{p=1}^{P} A_p y_{t-p} + \varepsilon_t \qquad \varepsilon_t | \Psi_{t-1} \sim \mathcal{N}(0, H_t) \tag{B1}$$

where Ψ_{t-1} represents all the information available up to $t-1$; y_t is a $k \times 1$ vector of endogenous variables conformed by the control variables described in Table B1. The matrix A_p of dimensions $K \times K$ represents the coefficients each p lag. Also, the selection of the optimal lag (P) is accomplished using the Akaike Information Criterion with a maximum lag of 5. The vector ε_t is assumed multivariate normal with a variance-covariance matrix H_t

$$\varepsilon = H_t^{1/2} u_t \qquad u_t \sim \mathcal{N}(0, I) \tag{B2}$$

As described by Engle III and Sheppard (2001), the matrix H_t can be expressed as

$$H_t = D_t R_t D_t \tag{B3}$$

where R_t represents a correlation matrix with the conditional correlations, and $D_t = \text{diag}\left\{(h_{i,t}^{1/2})\right\}$ the time-varying conditional standard deviations. The $h_{i,t}$ are estimated through a GARCH(1,1) model of the form

$$h_{i,t} = w + \alpha \varepsilon_{i,t-1}^2 + \beta h_{i,t-1} \tag{B4}$$

while the R_t structure is defined as

$$R_t = Q_t^{*-1} Q_t Q_t^{*-1} \tag{B5}$$

$$Q_t = (1 - \alpha - \beta)\,\bar{Q} + \alpha u_{t-1} u_{t-1}' + \beta Q_{t-1} \tag{B6}$$

$$Q_t^* = \text{diag}\left(Q_t^{1/2}\right) \tag{B7}$$

Table B1: Descriptive statistics for control variables

	Obs	Mean	Std	Min	Max
Control Variables					
Δ Policy Rate[(a)]	1,450	-0.010	0.262	-1.286	0.513
Δ FED Funds Rate[(a)]	1,450	-1.979	14.393	-96	25
Δ Inflation Rate[(a)]	1,450	-0.008	0.342	-0.960	0.790
Output Growth[(a)]	1,460	2.251	5.956	-14.271	16.201
Current Account/GDP[(a)]	1,450	-0.003	0.305	-1.385	1.157
External Debt/GDP[(a)]	1,450	0.088	1.139	-4.632	8.863
Δ Net International Reserves[(c)]	1,450	226.866	337.182	-674.798	1,402.414
FX Misalignments[(a)]	1,460	0	0.007	-0.021	0.018
Maturity Market Size[(a)]	1,450	85.250	4,039.415	-26,900	27,339.730
Δ VIX Index[(b)]	1,450	0.048	4.816	-15.280	20.500
Δ Brent Oil Prices	1,450	0.016	6.533	-25.650	13.730

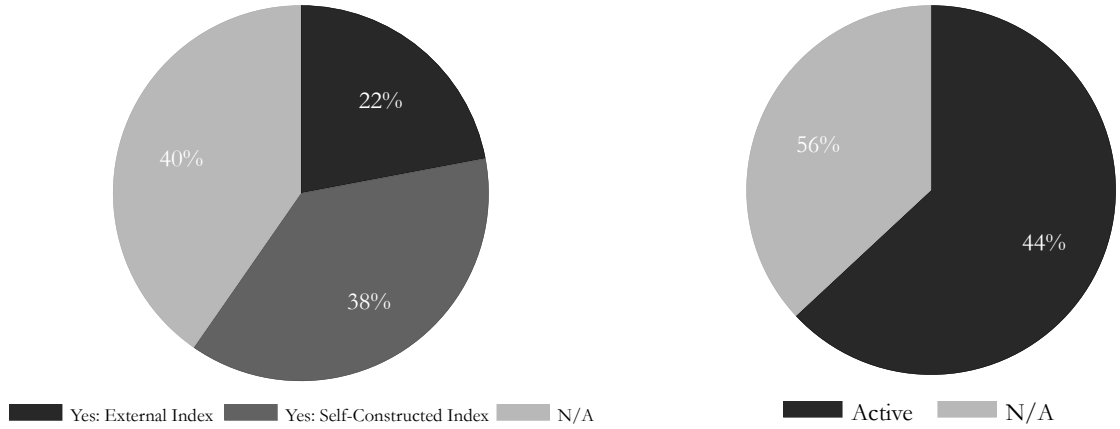
Note: Authors' calculations. [(a)] measured in %.[(b)] measured in 0-100 index or participation.[(c)] measured in million $USD.

Appendix C Surveys carried out by the Central Bank of Colombia

The Central Bank of Colombia frequently approaches foreign investors with participation in the TES market to learn about their investment strategies. Since 2018, over 40 agents have been consulted, representing around 70% of the total holdings of foreign investors. According to the information collected, the main drivers of long-term foreign investors in this markets are: i) fiscal and external vulnerabilities of the country; ii) long-term yield spreads with advanced economies; iii) the term structure of interest rates; iv) the behavior of the exchange rate against the dollar (Botero and Ruiz, 2023).

Furthermore, the polled agents have pointed out that investors following a short-term strategy over-weight other variables such as the local monetary policy and short-term interest rates. They have also highlighted that investors in short-term maturities may be seeking speculative objectives in many cases.

Figure C7: Colombia's Central Bank surveys



(a) Foreign investors following indexes (b) Foreign investors with portfolio management

Note: Panel (a) shows the percentage of foreign investors following either external indexes or self-constructed indexes. Panel (b) shows the percentages of foreign investors with active management of their portfolio. Source: Central Bank of Colombia, December 2023.

Many of these investors have stated that mutual funds face liquidity needs in the short term coming from regulatory requirements and redemption risk from retail investors putting their money in their funds. In that way, they need to manage liquidity by participating in money markets, such as the IBR-swap market,[19] and/or closing positions when they are in

[19]The Colombian IBR Swap is a financial derivative through which two parties exchange a fixed rate in Colombian pesos and a floating rate defined by the composition of the overnight IBR rate for a period of 3 months or more. The Reference Banking Indicator (IBR) is a short-term interest rate for the Colombian Peso, which reflects the price at which participants in its formation scheme are willing to offer or raise funds in the money market.

an early phase of distress. This is particularly the case in the Colombian TES market, since is less liquid than those of other relevant peers in the region. Thus, it would be harder for these foreign investors to sell their local assets when needed, so they sell Colombian bonds to enter better-conditioned markets, such as Mexico and Brazil, in which they can better deal with liquidity pressures.

Additionally, since 2023 foreign investors have been asked: i) if they follow any benchmark index when investing in TES; and ii) if they have some degree of active management over their portfolio in the country. As presented in Figure C7, approximately 60% of the foreign investor base in TES is indexed to a self-constructed index, or an external index like the GBI-EM. Furthermore, 56% of foreign holdings in the TES spot market report having some degree of active management of their portfolio.

Appendix D Robustness and Additional Exercises

Table D2: Dynamic effects: IRFs of market shares and concentrations

	Foreigners		Domestic Banks		Domestic Pension Funds	
	(1) i	(2) i Volatility	(3) i	(4) i Volatility	(5) i	(6) i Volatility
Panel A: Market Shares						
1	-0.035**	-0.005*	0.052***	0.014**	0.064***	0.013*
	(0.016)	(0.003)	(0.016)	(0.007)	(0.017)	(0.007)
2	-0.031*	-0.006*	0.051***	0.014**	0.073***	0.008
	(0.017)	(0.003)	(0.016)	(0.007)	(0.018)	(0.007)
3	-0.026	-0.011***	0.049***	0.019***	0.081***	0.001
	(0.017)	(0.004)	(0.017)	(0.007)	(0.018)	(0.007)
4	-0.019	-0.015***	0.044***	0.022***	0.095***	-0.004
	(0.017)	(0.004)	(0.017)	(0.008)	(0.017)	(0.007)
5	-0.015	-0.018***	0.038**	0.022***	0.108***	-0.007
	(0.018)	(0.004)	(0.016)	(0.007)	(0.017)	(0.006)
6	-0.011	-0.019***	0.032*	0.020***	0.110***	-0.007
	(0.018)	(0.004)	(0.016)	(0.007)	(0.017)	(0.006)
7	-0.008	-0.018***	0.027	0.014**	0.114***	-0.004
	(0.018)	(0.003)	(0.017)	(0.006)	(0.017)	(0.005)
8	-0.009	-0.017***	0.026	0.009**	0.112***	0.001
	(0.018)	(0.003)	(0.017)	(0.005)	(0.017)	(0.004)
9	-0.010	-0.017***	0.022	0.007	0.104***	0.002
	(0.018)	(0.003)	(0.016)	(0.004)	(0.017)	(0.004)
10	-0.013	-0.018***	0.021	0.006	0.098***	0.000
	(0.019)	(0.003)	(0.016)	(0.005)	(0.018)	(0.004)
11	-0.019	-0.020***	0.023	0.006	0.091***	-0.003
	(0.019)	(0.003)	(0.016)	(0.005)	(0.018)	(0.004)
12	-0.026	-0.022***	0.029*	0.006	0.091***	-0.006
	(0.019)	(0.003)	(0.016)	(0.005)	(0.018)	(0.004)
Panel B: Market Concentrations						
1	-0.044**	0.004	-0.015	0.009	0.007	-0.010
	(0.019)	(0.008)	(0.013)	(0.006)	(0.023)	(0.007)
2	-0.049**	0.001	-0.015	0.005	0.001	-0.002
	(0.019)	(0.008)	(0.013)	(0.006)	(0.024)	(0.008)
3	-0.056***	-0.003	-0.014	0.003	-0.008	0.004
	(0.020)	(0.007)	(0.013)	(0.007)	(0.025)	(0.008)
4	-0.068***	-0.005	-0.019	0.002	-0.014	0.009
	(0.019)	(0.006)	(0.013)	(0.006)	(0.025)	(0.008)
5	-0.077***	-0.010	-0.020	0.001	-0.021	0.013*
	(0.019)	(0.006)	(0.013)	(0.005)	(0.025)	(0.008)
6	-0.074***	-0.012**	-0.021	0.001	-0.027	0.015*
	(0.019)	(0.006)	(0.013)	(0.005)	(0.025)	(0.008)
7	-0.075***	-0.011*	-0.017	0.002	-0.036	0.011*
	(0.020)	(0.006)	(0.013)	(0.004)	(0.026)	(0.006)
8	-0.075***	-0.014***	-0.014	0.003	-0.040	0.010*
	(0.020)	(0.005)	(0.013)	(0.003)	(0.026)	(0.005)
9	-0.067***	-0.016***	-0.017	0.004	-0.035	0.008*
	(0.020)	(0.005)	(0.014)	(0.003)	(0.027)	(0.004)
10	-0.062***	-0.017***	-0.016	0.003	-0.033	0.012**
	(0.020)	(0.004)	(0.014)	(0.004)	(0.027)	(0.005)
11	-0.056***	-0.017***	-0.016	0.002	-0.032	0.015***
	(0.020)	(0.004)	(0.015)	(0.003)	(0.027)	(0.005)
12	-0.059***	-0.015***	-0.016	0.002	-0.034	0.017***
	(0.019)	(0.004)	(0.015)	(0.003)	(0.026)	(0.005)
Maturity FE	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓
Observations	1,450	1,440	1,450	1,440	1,450	1,440

Note: Authors' calculations. Dependent variables include the monthly bond yield (i) and bond yield volatility (i Volatility). Market shares and concentrations are standardized so that an impulse shock corresponds to one standard deviation. Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent level, respectively.

Table D3: Benchmark regressions with maturity interactions

	Foreigners		Banks		Pension Funds	
	(1) i	(2) i Volatility	(3) i	(4) i Volatility	(5) i	(6) i Volatility
Panel A: Market Shares						
Foreign Share$_{t-1}$	0.622***	0.057***	-0.036**	-0.005	-0.042***	-0.003
	(0.087)	(0.008)	(0.016)	(0.003)	(0.016)	(0.003)
Banks Share$_{t-1}$	0.040**	0.013*	-0.054	-0.004	0.048***	0.015**
	(0.017)	(0.007)	(0.051)	(0.006)	(0.016)	(0.007)
Pension Share$_{t-1}$	0.052***	0.013*	0.063***	0.014**	0.310***	-0.064***
	(0.017)	(0.007)	(0.017)	(0.007)	(0.090)	(0.013)
Foreign HHI$_{t-1}$	-0.031*	0.004	-0.046**	0.004	-0.036*	0.001
	(0.019)	(0.008)	(0.019)	(0.008)	(0.019)	(0.009)
Banks HHI$_{t-1}$	-0.001	0.011*	-0.013	0.009*	-0.010	0.007
	(0.012)	(0.006)	(0.013)	(0.006)	(0.013)	(0.005)
Pension HHI$_{t-1}$	-0.021	-0.013*	0.005	-0.010	0.008	-0.010
	(0.023)	(0.007)	(0.023)	(0.007)	(0.023)	(0.007)
Medium Section × Foreign Share$_{t-1}$	-0.666***	-0.075***				
	(0.078)	(0.010)				
Long Section × Foreign Share$_{t-1}$	-0.637***	-0.058***				
	(0.081)	(0.008)				
Medium Section × Banks Share$_{t-1}$			0.125**	0.027***		
			(0.050)	(0.008)		
Long Section × Banks Share$_{t-1}$			0.119**	0.012*		
			(0.052)	(0.007)		
Medium Section × Pension Share$_{t-1}$					-0.226***	0.070***
					(0.087)	(0.013)
Long Section × Pension Share$_{t-1}$					-0.263***	0.083***
					(0.089)	(0.014)
Maturity FE	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓
Observations	1,450	1,440	1,450	1,440	1,450	1,440
Panel B: Market Concentrations						
Foreign Share$_{t-1}$	-0.016	0.002	-0.035**	-0.005*	0.004	-0.000
	(0.014)	(0.003)	(0.016)	(0.003)	(0.014)	(0.004)
Banks Share$_{t-1}$	0.042***	0.012*	0.049***	0.015**	0.056***	0.015**
	(0.016)	(0.007)	(0.017)	(0.007)	(0.017)	(0.007)
Pension Share$_{t-1}$	0.057***	0.005	0.064***	0.012*	0.082***	0.016**
	(0.017)	(0.007)	(0.017)	(0.007)	(0.017)	(0.007)
Foreign HHI$_{t-1}$	-0.251***	-0.049***	-0.043**	0.005	-0.062***	0.001
	(0.056)	(0.010)	(0.019)	(0.008)	(0.019)	(0.009)
Banks HHI$_{t-1}$	-0.013	0.009*	0.016	-0.034***	0.015	0.012**
	(0.012)	(0.006)	(0.111)	(0.011)	(0.013)	(0.006)
Pension HHI$_{t-1}$	-0.004	-0.011	0.004	-0.009	0.201***	0.018***
	(0.021)	(0.007)	(0.022)	(0.007)	(0.056)	(0.006)
Medium Section × Foreign HHI$_{t-1}$	0.275***	0.058***				
	(0.055)	(0.008)				
Long Section × Foreign HHI$_{t-1}$	0.204***	0.064***				
	(0.056)	(0.008)				
Medium Section × Banks HHI$_{t-1}$			-0.003	0.052***		
			(0.110)	(0.011)		
Long Section × Banks HHI$_{t-1}$			-0.034	0.042***		
			(0.110)	(0.011)		
Medium Section × Pension HHI$_{t-1}$					-0.264***	-0.040***
					(0.055)	(0.009)
Long Section × Pension HHI$_{t-1}$					-0.286***	-0.039***
					(0.055)	(0.009)
Maturity FE	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓
Observations	1,450	1,440	1,450	1,440	1,450	1,440

Note: Authors' calculations. Dependent variables include the monthly bond yield (i) and bond yield volatility (i Volatility). Market shares and concentrations are standardized so that an impulse shock corresponds to one standard deviation. Medium Section and Long Section correspond to dummy variables for the medium and long segments of the curve, respectively. Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent level, respectively.

Table D4: Treatment effects - Omitting each year maturity at a time

	Excluded Maturity										
	Benckmark	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Panel A: Effect on i											
Foreign Share$_{t-1}$	-0.035**	0.016	-0.050***	-0.037**	-0.038**	-0.036**	-0.047**	-0.035**	-0.050***	-0.035*	-0.032*
	(0.016)	(0.010)	(0.016)	(0.017)	(0.018)	(0.017)	(0.019)	(0.018)	(0.018)	(0.018)	(0.017)
Banks Share$_{t-1}$	0.052***	0.059***	0.028*	0.042**	0.063***	0.050***	0.036**	0.063***	0.065***	0.072***	0.037**
	(0.016)	(0.015)	(0.016)	(0.019)	(0.020)	(0.019)	(0.018)	(0.017)	(0.017)	(0.017)	(0.017)
Domestic Pension Funds Share$_{t-1}$	0.064***	0.089***	0.028*	0.064***	0.076***	0.081***	0.072***	0.093***	0.060***	0.042**	0.044**
	(0.017)	(0.016)	(0.016)	(0.019)	(0.019)	(0.019)	(0.020)	(0.021)	(0.019)	(0.020)	(0.019)
Foreign HHI$_{t-1}$	-0.044**	-0.068***	-0.019	-0.052**	-0.054**	-0.065***	-0.027	-0.026	-0.040**	-0.058***	-0.025
	(0.019)	(0.017)	(0.019)	(0.022)	(0.022)	(0.022)	(0.022)	(0.021)	(0.020)	(0.021)	(0.020)
Banks HHI$_{t-1}$	-0.015	0.013	-0.008	-0.018	-0.016	-0.012	-0.014	-0.023	-0.027*	-0.030**	-0.020
	(0.013)	(0.011)	(0.013)	(0.013)	(0.015)	(0.014)	(0.016)	(0.016)	(0.015)	(0.014)	(0.014)
Domestic Pension Funds HHI$_{t-1}$	0.007	-0.069***	0.040*	0.021	0.003	0.005	0.009	0.010	0.014	0.017	0.017
	(0.023)	(0.020)	(0.024)	(0.027)	(0.027)	(0.025)	(0.025)	(0.024)	(0.024)	(0.024)	(0.023)
Maturity FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Time Fe	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	1,450	1,305	1,305	1,305	1,305	1,305	1,305	1,305	1,305	1,305	1,305
Panel B: Effect on i Volatility											
Foreign Share$_{t-1}$	-0.005*	0.001	-0.003	-0.004	-0.007**	-0.008**	-0.007*	-0.007**	-0.010***	-0.004	-0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
Banks Share$_{t-1}$	0.014**	0.014*	0.017**	0.015*	0.003	0.015*	0.019**	0.014**	0.014**	0.010	0.017**
	(0.007)	(0.007)	(0.008)	(0.008)	(0.004)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
Domestic Pension Funds Share$_{t-1}$	0.013*	0.013*	0.014*	0.015**	0.015**	0.015*	0.018**	0.008	0.014*	-0.000	0.019**
	(0.007)	(0.007)	(0.008)	(0.008)	(0.007)	(0.008)	(0.008)	(0.007)	(0.008)	(0.005)	(0.008)
Foreign HHI$_{t-1}$	0.004	0.004	0.003	0.003	0.011*	-0.001	0.000	0.004	0.004	0.009	-0.002
	(0.008)	(0.009)	(0.009)	(0.009)	(0.006)	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)	(0.009)
Banks HHI$_{t-1}$	0.009	0.009	0.009*	0.008	0.007	0.009	0.014*	0.016***	0.011*	-0.002	0.010*
	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.006)	(0.008)	(0.006)	(0.006)	(0.005)	(0.006)
Domestic Pension Funds HHI$_{t-1}$	-0.010	-0.018**	-0.013	-0.011	-0.000	-0.009	-0.013*	-0.011	-0.012	0.003	-0.013*
	(0.007)	(0.008)	(0.009)	(0.008)	(0.006)	(0.008)	(0.008)	(0.008)	(0.007)	(0.006)	(0.008)
Maturity FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Time Fe	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	1,440	1,296	1,296	1,296	1,296	1,296	1,296	1,296	1,296	1,296	1,296

Note: Authors' calculations. Dependent variables include the monthly bond yield (i) and bond yield volatility (i Volatility). Market shares and concentrations are standardized so that an impulse shock corresponds to one standard deviation. Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent level, respectively.

Table D5: Effects of treatments on outcomes of longer maturities

	Maturity+0		**Maturity+1**		**Maturity+2**		**Maturity+3**		**Maturity+4**	
	(1) i	(2) i Volatility	(3) i	(4) i Volatility	(5) i	(6) i Volatility	(7) i	(8) i Volatility	(9) i	(10) i Volatility
Market Shares & Concentrations										
Foreign Share$_{t-1}$	-0.035**	-0.005*	0.003	-0.002	0.032***	0.025***	0.051***	-0.003	0.052***	0.003
	(0.016)	(0.003)	(0.012)	(0.003)	(0.011)	(0.004)	(0.010)	(0.004)	(0.008)	(0.004)
Domestic Banks Share$_{t-1}$	0.052***	0.014**	0.029**	0.012**	0.031***	-0.006	0.030***	0.000	0.026***	-0.001
	(0.016)	(0.007)	(0.012)	(0.006)	(0.010)	(0.004)	(0.008)	(0.004)	(0.008)	(0.004)
Domestic Pension Funds Share$_{t-1}$	0.064***	0.013*	0.023	0.012**	-0.026**	-0.005	-0.042***	-0.022***	-0.018*	0.042***
	(0.017)	(0.007)	(0.014)	(0.006)	(0.013)	(0.005)	(0.011)	(0.007)	(0.010)	(0.007)
Foreign HHI$_{t-1}$	-0.044**	0.004	-0.005	-0.021***	-0.008	-0.017***	-0.012	0.018***	-0.001	-0.005
	(0.019)	(0.008)	(0.015)	(0.007)	(0.012)	(0.006)	(0.010)	(0.006)	(0.009)	(0.004)
Domestic Banks HHI$_{t-1}$	-0.015	0.009	-0.012	-0.006	-0.021**	-0.020***	-0.044***	0.001	-0.048***	0.012**
	(0.013)	(0.006)	(0.010)	(0.005)	(0.010)	(0.005)	(0.009)	(0.007)	(0.008)	(0.005)
Domestic Pension Funds HHI$_{t-1}$	0.007	-0.010	-0.007	-0.008	-0.015	-0.001	-0.012	-0.003	-0.024***	-0.022***
	(0.023)	(0.007)	(0.017)	(0.005)	(0.014)	(0.005)	(0.012)	(0.005)	(0.009)	(0.005)
Maturity FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	1,450	1,440	1,305	1,296	1,160	1,152	1,015	1,008	870	864

Note: Authors' calculations. Dependent variables include the monthly bond yield (i) and bond yield volatility (i Volatility). Market shares and concentrations are standardized so that an impulse shock corresponds to a one standard deviation. Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent level, respectively.

Table D6: Effects of treatments on outcomes of longer maturities - Part 2

	Maturity+5		**Maturity+6**		**Maturity+7**		**Maturity+8**	
	(1) i	(2) i Volatility	(3) i	(4) i Volatility	(5) i	(6) i Volatility	(7) i	(8) i Volatility
Market Shares & Concentrations								
Foreign Share$_{t-1}$	0.051***	0.002	0.076***	-0.006	0.062***	-0.020*	-0.017*	-0.001
	(0.008)	(0.006)	(0.010)	(0.009)	(0.015)	(0.011)	(0.009)	(0.014)
Domestic Banks Share$_{t-1}$	0.008	0.001	0.000	0.000	-0.015**	0.000	-0.027***	0.009
	(0.008)	(0.005)	(0.007)	(0.007)	(0.007)	(0.008)	(0.009)	(0.013)
Domestic Pension Funds Share$_{t-1}$	0.020	0.021**	0.002	-0.021*	-0.039**	-0.008	-0.067***	0.087***
	(0.013)	(0.010)	(0.013)	(0.011)	(0.016)	(0.017)	(0.015)	(0.026)
Foreign HHI$_{t-1}$	0.006	0.002	-0.002	-0.027***	-0.022**	0.028**	-0.028***	0.014
	(0.010)	(0.007)	(0.009)	(0.010)	(0.011)	(0.013)	(0.010)	(0.031)
Domestic Banks HHI$_{t-1}$	-0.049***	0.015	-0.045***	0.038***	-0.031**	0.043**	0.012	-0.092**
	(0.015)	(0.014)	(0.017)	(0.012)	(0.014)	(0.019)	(0.019)	(0.040)
Domestic Pension Funds HHI$_{t-1}$	-0.030***	-0.027***	-0.024***	0.007	-0.000	0.011	-0.012*	0.005
	(0.009)	(0.006)	(0.007)	(0.008)	(0.006)	(0.008)	(0.007)	(0.015)
Maturity FE	✓	✓	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓	✓	✓
Observations	725	720	580	576	435	432	290	288

Note: Authors' calculations. Dependent variables include the monthly bond yield (i) and bond yield volatility (i Volatility). Market shares and concentrations are standardized so that an impulse shock corresponds to a one standard deviation. Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent level, respectively.

Table D7: Effects of treatments on outcomes of shorter maturities

	Maturity-0		**Maturity-1**		**Maturity-2**		**Maturity-3**		**Maturity-4**	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	i	i Volatility	i	i Volatility	i	i Volatility	i	i Volatility	i	i Volatility
Market Shares & Concentrations										
Foreign Share$_{t-1}$	-0.035**	-0.005*	-0.009	-0.005	-0.033**	-0.010***	-0.017	-0.010*	-0.028	-0.004
	(0.016)	(0.003)	(0.014)	(0.003)	(0.014)	(0.004)	(0.016)	(0.006)	(0.019)	(0.004)
Domestic Banks Share$_{t-1}$	0.052***	0.014**	0.068***	-0.011**	0.041*	0.004	-0.039	-0.008	-0.108***	0.011*
	(0.016)	(0.007)	(0.020)	(0.005)	(0.021)	(0.005)	(0.025)	(0.007)	(0.028)	(0.006)
Domestic Pension Funds Share$_{t-1}$	0.064***	0.013*	0.132***	0.010**	0.118***	0.009	0.109***	-0.021*	0.108***	0.022***
	(0.017)	(0.007)	(0.022)	(0.005)	(0.021)	(0.006)	(0.018)	(0.012)	(0.019)	(0.005)
Foreign HHI$_{t-1}$	-0.044**	0.004	-0.101***	0.017**	-0.093***	-0.035***	-0.098***	0.007	-0.056**	-0.010
	(0.019)	(0.008)	(0.022)	(0.007)	(0.021)	(0.006)	(0.024)	(0.007)	(0.025)	(0.007)
Domestic Banks HHI$_{t-1}$	-0.015	0.009	0.014	-0.013**	0.031**	0.025***	0.054***	0.010	0.030	-0.016**
	(0.013)	(0.006)	(0.015)	(0.006)	(0.013)	(0.005)	(0.014)	(0.011)	(0.019)	(0.008)
Domestic Pension Funds HHI$_{t-1}$	0.007	-0.010	-0.083***	0.012*	-0.071***	-0.001	-0.090***	0.012	-0.008	-0.007
	(0.023)	(0.007)	(0.027)	(0.006)	(0.022)	(0.005)	(0.024)	(0.007)	(0.035)	(0.010)
Maturity FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	1,450	1,440	1,305	1,296	1,160	1,152	1,015	1,008	870	864

Note: Authors' calculations. Dependent variables include the monthly bond yield (i) and bond yield volatility (i Volatility). Market shares and concentrations are standardized so that an impulse shock corresponds to a one standard deviation. Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent level, respectively.

Table D8: Effects of treatments on outcomes of shorter maturities - Part 2

	Maturity-5		**Maturity-6**		**Maturity-7**		**Maturity-8**	
	(1) i	(2) i Volatility	(3) i	(4) i Volatility	(5) i	(6) i Volatility	(7) i	(8) i Volatility
Market Shares & Concentrations								
Foreign Share$_{t-1}$	-0.071***	0.021***	-0.081***	0.017*	-0.024	0.010*	-0.039	-0.006
	(0.023)	(0.005)	(0.019)	(0.009)	(0.037)	(0.006)	(0.041)	(0.010)
Domestic Banks Share$_{t-1}$	-0.132***	0.017	0.080***	-0.023*	0.173***	0.039***	0.129	-0.046**
	(0.043)	(0.017)	(0.030)	(0.012)	(0.062)	(0.009)	(0.080)	(0.023)
Domestic Pension Funds Share$_{t-1}$	0.055***	0.001	0.062**	-0.017*	0.086***	0.006	0.090***	-0.016**
	(0.021)	(0.009)	(0.026)	(0.010)	(0.031)	(0.005)	(0.030)	(0.008)
Foreign HHI$_{t-1}$	0.090***	-0.009	0.014	0.050***	0.028	0.013*	0.048*	0.030***
	(0.027)	(0.013)	(0.030)	(0.012)	(0.028)	(0.008)	(0.027)	(0.008)
Domestic Banks HHI$_{t-1}$	0.006	0.010	-0.023	-0.035***	-0.128***	-0.013	-0.199***	-0.009
	(0.018)	(0.007)	(0.019)	(0.012)	(0.045)	(0.008)	(0.058)	(0.010)
Domestic Pension Funds HHI$_{t-1}$	0.028	-0.054***	0.031	0.005	-0.139*	-0.041***	0.071	0.039*
	(0.032)	(0.016)	(0.031)	(0.016)	(0.072)	(0.009)	(0.083)	(0.022)
Maturity FE	✓	✓	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓	✓	✓
Observations	725	720	580	576	435	432	290	288

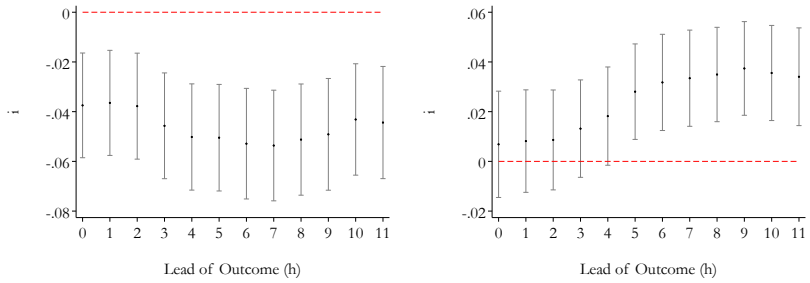
Note: Authors' calculations. Dependent variables include the monthly bond yield (i) and bond yield volatility (i Volatility). Market shares and concentrations are standardized so that an impulse shock corresponds to a one standard deviation. Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent level, respectively.

Table D9: Benchmark results within foreign investors - Panel OLS with fixed effects

	—Benchmark—					
	(1)	(2)	(3)	(4)	(5)	(6)
	i	i Volatility	i	i Volatility	i	i Volatility
Market Shares & Concentrations						
Foreign Share$_{t-1}$	-0.044***	-0.005	-0.034***	-0.006**		
	(0.016)	(0.003)	(0.013)	(0.003)		
Banks Share$_{t-1}$	0.045***	0.016***	0.040***	0.013***		
	(0.015)	(0.005)	(0.014)	(0.004)		
Pension Share$_{t-1}$	0.059***	0.015***	0.043***	0.015***		
	(0.015)	(0.006)	(0.013)	(0.005)		
Foreign Banks HHI$_{t-1}$	-0.037***	-0.000			-0.007	0.008***
	(0.013)	(0.004)			(0.012)	(0.003)
Mutual Funds HHI$_{t-1}$	0.007	-0.002			0.007	-0.002
	(0.013)	(0.003)			(0.013)	(0.003)
Banks HHI$_{t-1}$	-0.019	0.009*			-0.012	0.012**
	(0.013)	(0.005)			(0.014)	(0.006)
Pension HHI$_{t-1}$	0.015	-0.012**			0.035**	-0.003
	(0.020)	(0.005)			(0.016)	(0.004)
Maturity FE	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓
Observations	1,450	1,440	1,450	1,440	1,450	1,440

Note: Authors' calculations. Dependent variables include the monthly bond yield (i) and bond yield volatility (i Volatility). Market shares and concentrations are standardized so that an impulse shock corresponds to one standard deviation. Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1, 5, and 10 percent level, respectively.

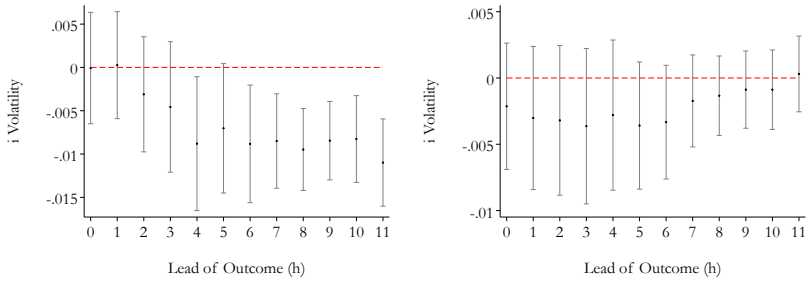
Figure D8: IRF Figures - Foreign banks and mutual funds concentrations vs Yields



(a) Foreign banks (b) Mutual funds

Note: Authors' calculations using robust confidence intervals significant at 10 percent level.

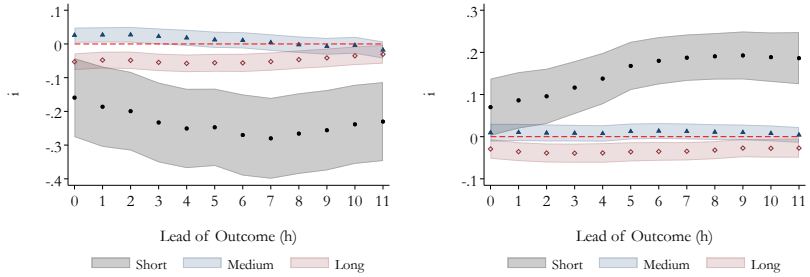
Figure D9: IRF Figures - Foreign banks and mutual funds concentrations vs Yield Volatility



(a) Foreign banks (b) Mutual funds

Note: Authors' calculations using robust confidence intervals significant at 10 percent level.

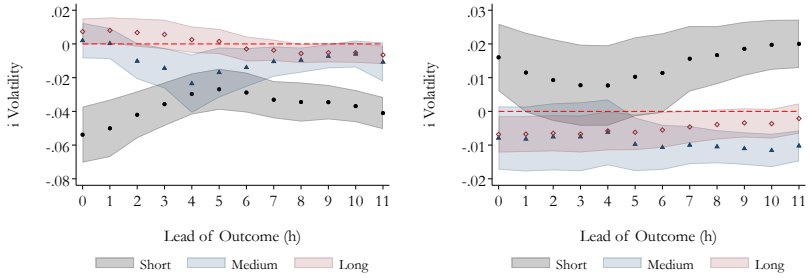
Figure D10: IRF Figures - Foreign banks and mutual funds concentrations vs Yields by maturity



(a) Foreign banks (b) Mutual funds

Note: Authors' calculations using robust confidence intervals significant at 10 percent level.

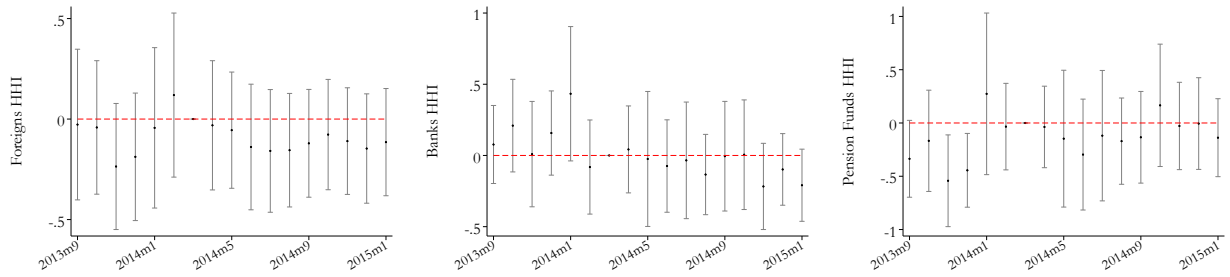
Figure D11: IRF Figures - Foreign banks and mutual funds concentrations vs Yield Volatility by maturity



(a) Foreign banks (b) Mutual funds

Note: Authors' calculations using robust confidence intervals significant at 10 percent level.

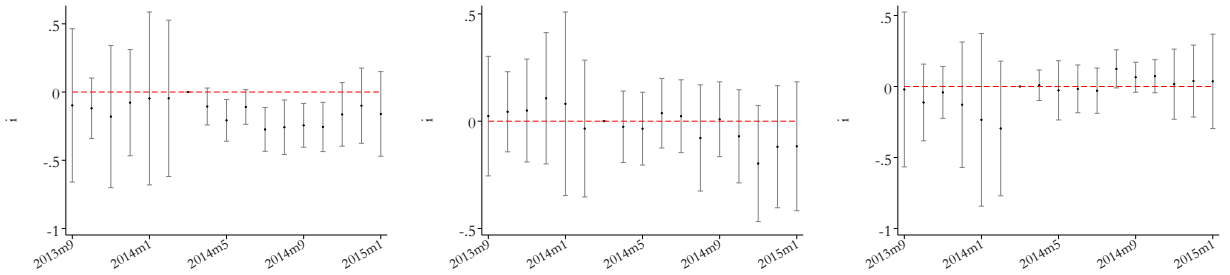
Figure D12: J.P. Morgan shock on market concentrations



(a) Foreign HHI (b) Banks HHI (c) Pension Funds HHI

Note: Authors' calculations. The figure presents coefficients from the regression in equation (2), with robust confidence intervals significant at 10 percent level.

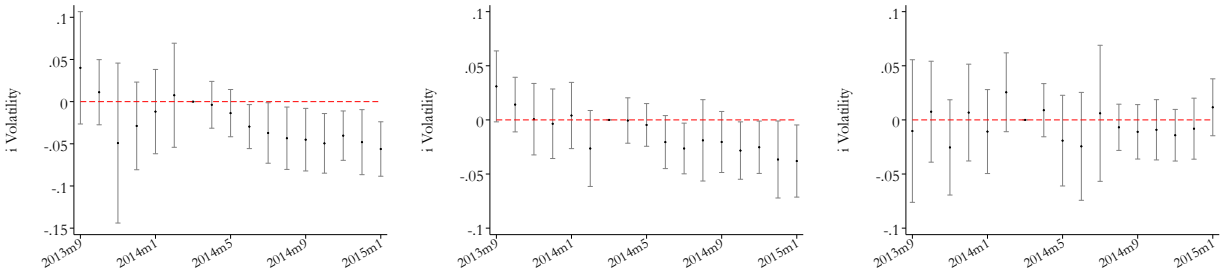
Figure D13: J.P. Morgan Shock on i through shares



(a) Foreigns share (b) Banks share (c) Pension funds share

Note: Authors' calculations. The figure shows interaction coefficients from the regression presented in equation (3), with robust confidence intervals significant at 10 percent level.

Figure D14: J.P. Morgan shock on i Volatility through shares



(a) Foreigns share (b) Banks share (c) Pension funds share

Note: Authors' calculations. The figure shows interaction coefficients from the regression presented in equation (3), with robust confidence intervals significant at 10 percent level.

Table D10: IV First stage (one and two months lags)

	(1) Foreign Share$_{t-1}$	(2) Domestic Banks Share$_{t-1}$	(3) Domestic Pension Funds Share$_{t-1}$	(4) Foreign HHI$_{t-1}$	(5) Domestic Banks HHI$_{t-1}$	(6) Domestic Pension Funds HHI$_{t-1}$
Market Shares & Concentrations						
Foreign Share$_{t-2}$	0.951***	-0.038	-0.016	-0.052*	0.018	0.054
	(0.023)	(0.036)	(0.016)	(0.029)	(0.028)	(0.041)
Domestic Banks Share$_{t-2}$	0.001	0.833***	-0.015	0.035	-0.047*	0.126
	(0.014)	(0.041)	(0.024)	(0.047)	(0.026)	(0.084)
Domestic Pension Funds Share$_{t-2}$	-0.002	-0.004	0.913***	0.092**	0.023	0.059
	(0.019)	(0.052)	(0.021)	(0.042)	(0.050)	(0.044)
Foreign HHI$_{t-2}$	0.009	-0.036	0.010	0.735***	-0.021	0.005
	(0.013)	(0.033)	(0.019)	(0.039)	(0.030)	(0.051)
Domestic Banks HHI$_{t-2}$	-0.014	-0.082**	0.024	-0.059	0.763***	0.173***
	(0.019)	(0.032)	(0.032)	(0.046)	(0.060)	(0.055)
Domestic Pension Funds HHI$_{t-2}$	0.030**	0.144***	0.014	0.088	0.119***	0.610***
	(0.014)	(0.041)	(0.034)	(0.060)	(0.031)	(0.064)
Foreign Share$_{t-3}$	-0.076**	0.013	-0.016	0.038	-0.001	-0.042
	(0.029)	(0.035)	(0.018)	(0.028)	(0.029)	(0.043)
Domestic Banks Share$_{t-3}$	-0.006	-0.022	-0.004	-0.037	0.004	-0.132*
	(0.015)	(0.035)	(0.023)	(0.041)	(0.023)	(0.069)
Domestic Pension Funds Share$_{t-3}$	-0.026	-0.027	-0.081***	-0.107**	0.089	0.002
	(0.020)	(0.054)	(0.029)	(0.045)	(0.061)	(0.052)
Foreign HHI$_{t-3}$	-0.001	0.067**	0.024	0.073*	-0.042	0.011
	(0.015)	(0.034)	(0.024)	(0.037)	(0.036)	(0.042)
Domestic Banks HHI$_{t-3}$	0.010	0.056**	-0.003	0.094***	-0.020	-0.119***
	(0.012)	(0.027)	(0.023)	(0.032)	(0.046)	(0.044)
Domestic Pension Funds HHI$_{t-3}$	-0.022*	-0.058*	-0.001	-0.085**	-0.047**	0.145***
	(0.013)	(0.031)	(0.021)	(0.042)	(0.021)	(0.050)
Maturity FE	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓
Instruments F Test	302	199	306	168	170	219
Observations	1,430	1,430	1,430	1,430	1,430	1,430

Note: Authors' calculations. Each row displays the F statistic and associated p-values for the first stage of each treatment variable. The table shows the first stage tests using the lags 2 and 3 of each share and HHI.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