WORKING paper

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Heterogeneity in Bank Leverage: the Funding Channels of Complexity

Matthieu Bussière[1], Baptiste Meunier[2] and Justine Pedrono[3]

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Abstract

This paper assesses the net impact of complexity on leverage, at the Bank Holding Companies (BHCs) level using unique French supervisory data from 2010 to 2017. Geographical and structural complexity introduce diversification benefits and agency problems that affect the risk of BHCs. Whether investors price this risk or not is decisive for the cost of equity and finally leverage. Our results show a negative impact of complexity on leverage. To explain this result, we then focus on the funding channels of complexity. We find that complexity goes hand in hand with additional capital surplus and increasing cost of equity. As a second major finding, our results show that the impact of complexity on leverage and the funding channels of complexity are heterogeneous across BHCs and depend on their systemic status. In fact, size, complexity and systemic status complement each other. Omitting one of these dimensions leads to misleading conclusions on bank stability.

Keywords: bank, complexity, risk, capital structure, leverage, cost of equity, funding cost, capital requirements.

JEL classification: F33, F36, F65, G15, G21

[1] Banque de France, Matthieu.BUSSIERE@banque-france.fr
[2] Banque de France, Baptiste.MEUNIER@banque-france.fr
[3] Banque de France, Justine.PEDRONO@acpr.banque-france.fr

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NON-TECHNICAL SUMMARY

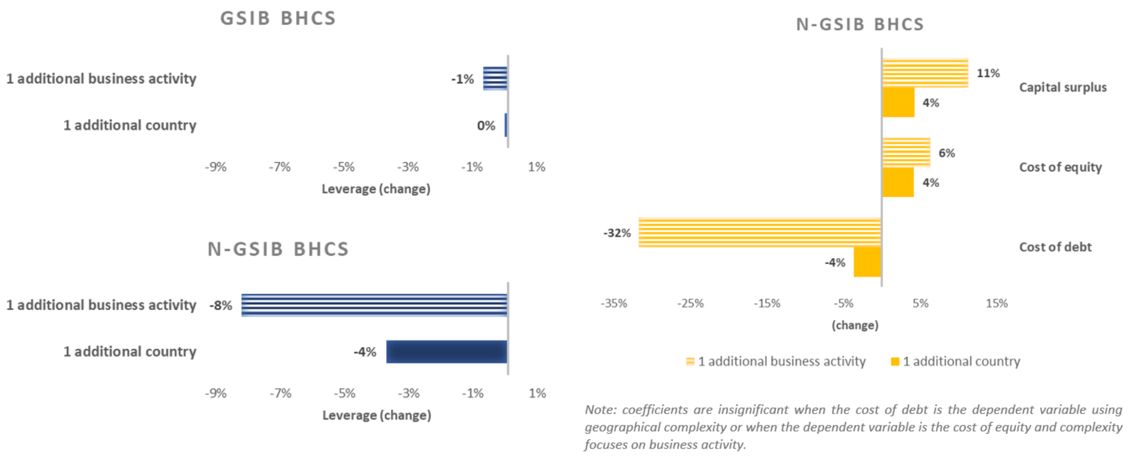
This paper assesses the net impact of complexity on leverage, at the Bank Holding Companies (BHCs) level. As leverage of BHCs is a risk factor that drives bank systemic risk, assessing the net impact of bank complexity on leverage is of the utmost importance to banking supervisors. Using unique supervisory data from 2010 to 2017, we focus on BHCs located in France and provide novel descriptive statistics on geographical and structural complexity. In this paper, complexity measures are based either on the international implementation of BHCs affiliates or on the business activities covered by BHCs through their affiliates specialization.

Leverage, defined as the ratio of total assets over equity, is derived from a trade-off between the fiscal benefit of debt and the cost of equity. Depending on how the relationship between complexity and risk is perceived by investors, complexity may affect the cost of equity and leverage. Assuming that complexity decreases risk thanks to risk diversification, the capital structure theory suggests that complexity reduces the cost of equity and increases bank optimal leverage. But as complexity increases bank risk for significant monitoring costs and agency problems, complexity potentially increases the cost of equity, leading to an increase in capital and a decline in leverage. The net impact of complexity on leverage is then ambiguous.

Empirically, the literature shows that complexity - implying income-based and asset-based diversification - introduces a diversification discount on financial conglomerates market values. It supports the agency problem hypothesis where investors price the additional risk due to complexity. All in all, it suggests that significant level of complexity may constrain leverage through high cost of equity.

Our data include information on complexity, accounting variables and prudential indicators at the BHCs level. Our data show a strong heterogeneity in complexity between systemic BHCs and other BHCs. Systemic BHCs account for 80\% of the total affiliates reported by all BHCs. While both the number of countries and the number of industries a BHC is active in decrease for systemic BHCs over the period, the number of countries increases and the number of industries stays quite stable for other BHCs. The particular profile of systemic BHCs is also observed in major bank control variables and we believe that the relationship between complexity, risk and leverage depends on BHCs profile (systemic Vs other).

Our results, summarized in Figure 1)a), first indicate a non-monotonic relationship between leverage and complexity. Complexity implies lower leverage for non systemic BHCs than for systemic BHCs. It suggests that monitoring costs and agency problems outweigh diversification benefits for non systemic BHCs. Then, our results show that size, complexity and systemic importance add information on BHCs. Because they complement each other, omitting one of these dimension leads to misleading conclusions on leverage and the financial stability of BHCs. In a second time, we extend our analysis to the funding channels of complexity to explain our results on leverage. As reported in Figure 1)b), we focus on capital surplus and funding costs and we confirm the asymmetry between systemic BHCs and other BHCs. Due to complexity, non systemic BHCs are subject to additional capital constraints, implying both higher level of capital (i.e volume of capital) and larger cost of capital. Regarding systemic BHCs, they are only concerned by volumes and to a lesser extend than non-systemic BHCs. These additional capital constraints limit the development of leverage in the first place, especially as complexity implies limited benefits with regards to the cost of debt.



a. Impact of complexity on leverage

b. The funding channels of complexity

Figure 1) Heterogeneity in bank leverage: the funding channels of complexity. Two types of complexity are considered in this figure: geographical complexity (number of countries) and structural complexity (number of different business activities). The left panel shows that higher complexity significantly reduces leverage for non-systemic BHCs; the result does not hold for systemic BHCs, showing heterogeneity in the impact of complexity. The right panel shows that this result for non-systemic BHCs is driven by higher capital surplus, higher cost of equity, and lower cost of debt when complexity increase.

Hétérogénéité du levier bancaire: les canaux de transmission de la complexité sur le financement

Résumé

Ce papier estime l'impact net de la complexité sur le levier au niveau des groupes bancaires. En exploitant des données de supervision sur la période 2010-2017, nous détaillons de nouvelles statistiques descriptives sur la complexité géographique et structurelle des groupes bancaires présents en France. La complexité, qui mesure la diversification des activités bancaires et géographiques, peut être perçue comme une source de risque. La façon dont les investisseurs intègrent ce risque dans la valorisation du capital est alors déterminante pour le coût du capital des groupes bancaires, et finalement, pour leur levier. Nos résultats montrent que la complexité a un effet négatif sur le levier, suggérant que la complexité augmente le risque et le coût du capital. Pour expliquer cet effet négatif, nous détaillons dans un second temps le lien entre la complexité et les canaux de financement des groupes bancaires. Nous trouvons que la complexité est associée à un coût et un surplus du capital plus élevés. Nos résultats montrent également que l'effet de la complexité sur le risque et les canaux de transmissions sont très hétérogènes selon les statuts des groupes bancaires. Enfin, nos résultats montrent que la taille, la complexité et la systémicité sont complémentaires pour expliquer le risque bancaire. Omettre une de ces variables impliquerait des erreurs d'estimation et de recommandation pour la stabilité financière.

Mots-clés : banque, complexité, risque, structure du capital, levier, coût du capital, coût de financement, exigences en capitaux.

1 Introduction

In the aftermath of the global financial crisis, banks' size and leverage have been the two main concerns of banking supervisors. Since then, the debate shifted to broader topics such as systemic importance and complexity. Complexity - defined as the multiplicity of activities a bank is involved in or the geographic diversification of banking activities - captures the different bank exposures. Compare to size, it provides detailed information on the potential interconnection and synergies between the different activities a bank is active in as well as potential side effects. Measuring complexity and its consequences on banking stability is then a subject of keen interest. In this regards, this paper focuses on the net impact of complexity on leverage, distinguishing the different funding channels of complexity. More broadly, and as part of the new IBRN initiative on bank complexity, this paper links the complexity of Bank Holding Companies (BHCs) with risk.[1]

Focusing on the recent literature, the relationship between bank complexity and bank risk is ambiguous, including either positive or negative impact of complexity on risk. On the one hand, complexity introduces diversification benefits and economies of scope. Focusing on bank credit risk, Fang and Van Lelyveld [2014] show that geographical diversification reduces bank risk. The benefits of international diversification are also supported by Meslier et al. [2016] while focusing on default risk and risk-adjusted returns. On the other hand, complexity may imply additional risks or new costs, including monitoring costs, that might outweigh benefits. The greater impact of monitoring costs is supported in Buch et al. [2013] while Gulamhussen et al. [2013], Goetz et al. [2013] show that new markets due to internationalization increase risk exposure, confirming the dominance of the risk market hypothesis over the international diversification risk hypothesis. De Jonghe [2010] also confirms that complexity increases risk focusing on the diversity of activities a bank is active in. He finds that a shift to non-traditional banking activities increases banks risk. Alternatively, Liu et al. [2015], Buch et al. [2013], Cetorelli and Traina [2018] reconcile these two strands of the literature by identifying a non-monotonic relationship between complexity and risk. Interestingly in their results, the negative impact of complexity on risk is

[1] The International Banking Research Network (IBRN) is a network of central bank researchers focusing on global banking issues. It started a new set of cross-country studies in 2018 that focuses on bank complexity. See IBRN for details.

especially observable in the early stage of complexity, supporting the idea of an entry cost.

In addition to the diversification channel, complexity also introduces agency problems. These agency problems are related to the "Too-Big-to-Fail" (TBTF) dimension of banks and the implicit bail-out guarantee. It introduces a lack of market discipline and lower financing costs. Because of it, banks have an incentive to take on more risk. In addition to size, Farhi and Tirole [2012], Acharya et al. [2016] show that complexity is also a determinant of TBTF, linking complexity to the TBTF agency problem. In this vein, Laeven and Levine [2007], Goetz et al. [2013], Guerry and Wallmeier [2017] show that complexity - implying income-based and asset-based diversification - introduces a diversification discount on financial conglomerates market values. It supports the agency problem hypothesis where investors price the additional risk due to complexity.

Following the corporate finance literature on capital structure determinants (Rajan and Zingales [1995], Gropp and Heider [2010]), this paper assesses the net impact of complexity on leverage, at the BHCs level. Leverage, defined as the ratio of total assets over equity, is derived from a trade-off between the fiscal benefit of debt and the cost of equity. Tax-deductible interest introduces an incentive for banks to be leveraged. However, this incentive is limited by the cost of equity which increases with leverage and the probability of bankruptcy. In addition to the trade-off mechanism, BHCs are subject to banking regulation. The latter constrains BHCs to fulfill capital requirements in order to secure banking stability and impacts leverage. As complexity impacts risk, one may expect that complexity also impacts leverage through the cost of equity and capital. Assuming that complexity decreases risk thanks to risk diversification, the capital structure theory suggests that complexity reduces the cost of equity and increases bank optimal leverage. But as complexity increases bank risk for significant monitoring costs and agency problems, complexity potentially increases the cost of equity, leading to an increase in capital and a decline in leverage. Therefore, the net impact of complexity on leverage is then ambiguous.

We focus on leverage for four main reasons. First and to the best of our knowledge, the link between the capital structure of BHCs and complexity has not been analyzed in the recent literature. Second, leverage of BHCs is a risk factor that drives bank systemic risk (Laeven et al. [2016]). Assessing the net impact of bank complexity on leverage is of the utmost importance to banking supervisors. Third, Miller [1995], Miles et al. [2012] show that the capital structure theory is still relevant for banks even with the introduction of regulation and implicit or explicit deposit guarantees. Fourth, it allows us to extend our analysis in order to identify the underlying mechanisms through which complexity affects leverage. Focusing on the effect of complexity on risk, capital surplus and funding costs, we are able to dig deeper in the relationship between complexity and leverage.

One specificity of the French banking system is the strong heterogeneity in BHCs. It includes both French and foreign BHCs and we identify no less than 5 systemic BHCs from 2010 to 2017. This significant number of systemic BHCs makes France as a natural candidate to study heterogeneity either between systemic BHCs and other BHCs or even within BHCs. Following Meslier et al. [2016], the impact of complexity is heterogeneous across BHCs and depends on the characteristics of BHCs. Therefore, this framework allows us to test the conditional impact of complexity on leverage and the funding channels relative to one specific characteristic of BHCs, namely the systemic status. We believe that making use of such an heterogeneity constitutes a determinant contribution in the comprehension of banking stability.

To do so, we build an unique dataset on BHCs located in France from 2010 to 2017. It includes information on complexity, accounting variables and prudential indicators at the BHCs level. Following Cetorelli and Goldberg [2014], Goldberg and Meehl [2019], two different types of complexity measures are developed. The first one relates to geographical complexity in order to picture the international span of BHCs. The second captures the structural dimension of complexity, including the different business activities spanned by affiliates. We believe that these two types of complexity fit for capturing the diversification channel and the agency problem hypothesis. Moreover, these definitions of complexity go beyond the usual components retained to identify BHCs as systemic, and more generally, to assess risk. In other words, these measures of complexity bring new information on the characteristics of BHCs.

Our results first indicate the non-monotonic relationship between leverage and complexity. Complexity implies lower leverage for non systemic BHCs than for systemic BHCs. It suggests that monitoring costs and agency problems outweigh diversification benefits for non systemic BHCs. Then, our results show that size, complexity and systemic importance add information on BHCs. Because they complement each other, omitting one of these dimensions leads to misleading conclusions on the financial stability of BHCs. In a second time, we extend our analysis to the funding channels of complexity to explain our conclusion on leverage. We focus on capital surplus and funding costs and we confirm the asymmetry between systemic BHCs and other BHCs. Due to complexity, non systemic BHCs are subject to additional capital constraints in terms of volume and costs, while systemic BHCs are only concerned by volumes and to a lesser extend than non-systemic BHCs. These additional capital constraints limit the development of leverage in the first place, especially as complexity implies limited benefits with regards to the cost of debt.

The remainder of the paper is organized as follows. Section 2 presents our data in details and provides novel descriptive statistics on BHCs located in France from 2010 to 2017. It describes complexity of BHCs and underlines the strong heterogeneity between systemic BHCs and other BHCs. Section 3 focuses on the net impact of complexity on leverage. It extends the discussion on the conditional impact of complexity and systemic importance. The funding channels of complexity are developed in section 4. Section 5 concludes.

2 Data

2.1 The French banking system

The French banking system is specific in the sens that it is concentrated around a significant number of five systemic BHCs. The seed of the French specificity goes back to 1984, where the French government introduced a common legal framework in France. This was the starting point to decompartmentalize credit and to deregulate the banking system. From 1987 to 2002, governments have made a series of banking privatizations. It started in 1987 with Paribas and Société

Générale, followed in 1988 with the the mutualization of Crédit Agricole. After a small break from in 1989 to 1993, privatizations started again with BNP in 1993 and Credit Lyonnais in 1999.

The economic and financial crisis during the 90's went along with the introduction of an European framework to unify financial markets and banking systems. Simultaneously, these two events provided a perfect environment for competition and restructuration in the banking system. Several significant mergers and acquisitions are observed at that time. In particular, BNP lunched a double Public Exchange Offer in 1999, targeting Société Générale and Paribas. After a semester of confrontation, the merger between BNP and Société Générale failed and BNP Paribas emerged as a major player of the banking system.

More generally, the concentration of the banking system accelerated from 1984 to 2008. In 1984, the French banking system counted 1556 banks.[2] In 1998, total banks declined to 1000 banks, while only 342 banks were registered in 2008. Over the period 1998-2008, we observed in the French banking system a decline of 65% of banks and an increase of 230% of the total aggregated balance sheet.[3] A fewer banks captured more and more banking activity. In 2017, 87% of total assets held by French banks are held by the six largest banking groups (BNP Paribas, BPCE, Crédit Agricole, Crédit Mutuel, La Banque Postale and Société Générale).

2.2 Sample

We build a unique dataset on BHCs located in France that includes information on complexity metric, accounting variables and prudential indicators. All data come from the ACPR. Our sample consists of 40 Bank Holding Companies (BHCs) between 2010 and 2017. It includes 27 banks, 4 cooperative banks and 9 specific financial institutions. Over the 40 BHCs, 12 are foreign (based on shareholder nationality) including American, Belgian, British, Canadian, Italian,

[2]Sources: La Fédération Bancaire Française (http://www.fbf.fr/fr/secteur-bancaire-francais/histoire/vi-une-nouvelle-revolution-bancaire).

[3]See "Rapport chiffre ACPR" for more details:
https://acpr.banque-france.fr/sites/default/files/medias/documents/2009-rapport-annuel-de-l-autorite-de-controle-prudentiel.pdf;
https://acpr.banque-france.fr/sites/default/files/medias/documents/rapport_chiffres_acpr_2017_4.pdf;
https://acpr.banque-france.fr/sites/default/files/medias/documents/les_chiffres_du_marche_francais_de_la _banque_ et_de_lassurance_2018.pdf

Lebanese and Swiss BHCs.

To build our complexity measures, we merge two tables. From 2010 to 2013, all BHCs report the "Implantat" table that includes information on bank complexity. From 2014 to 2017, BHCs under the IFRS accounting standard report the "Finrep 40.01" table on bank group structure while smaller BHCs under the French accounting standard continue to report the "Implantat table". Both the "Implantat" and the "Finrep 40.01" tables contain similar information to guarantee consistent definitions of complexity measures at the BHCs level over time.

Two types of complexity are considered in this paper, the geographical complexity and the structural complexity. Both are based on a counting method relative to affiliates reported by each BHC. Following the literature on complexity, we retain all affiliates for which BHCs have a voting right of at least 50%. The geographical complexity is measured through $Span\_c$, $count\_foreign$ and $count\_FR$. $Span\_c$ counts the number of countries a BHC is active in while $count\_foreign$ and $count\_FR$ count the number of affiliates by BHC that are not located in France and the number of affiliates that are located in France, respectively. The structural complexity is measured with $total\_count$, $count\_bank$, $count\_nonbank$ and $span\_bus\_type$. The later counts the number of business types a BHC has subsidiaries specialized in, while $total\_count$, $count\_bank$ and $count\_nonbank$ counts affiliates by BHC, the active affiliates in commercial banking by BHC and the affiliates that are no classified as credit institutions by BHC, respectively.

For each BHC, we then define $Size$ as the logarithm of total assets and $leverage$ as the ratio of total assets over equity. To measure the risk of BHCs, we use two definitions. First, the Risk Weighted Asset density (RWA_Dens) provides information on risk exposure relative to assets. It assesses risk on a prudential basis considering credit risk, market risk and operational risk associated to each asset. Because it focuses on the risk of assets taken separately and because it does not consider synergies between business activities, this measure of risk differs from other sources of risks implied by complexity. The second measure of risk is the standard deviation of returns on assets (RoA) over the period. It is a static measure that provides information on the risk of BHCs known by all investors over the total period. It says how volatile the profit of the

BHC is, considering all sources of incomes and expenses declared in the income statement of the BHC. This measure of risk is broader than the RWA density as it includes components linked to liabilities, potential synergies between assets and liabilities and synergies between the different business activities the BHCs are involved in. Unfortunately, this measure is not appropriate to provide information for each period, limiting the analysis to the cross-section heterogeneity. Because BHCs are not all publicly tradable, we can not use alternative measures of risk based on market data. Because of the lack of market data, the cost of equity (CoE) of BHCs is estimated using returns on equity as a proxy of the cost equity.[4] Cost of debt (CoD) of BHCs is based on accounting data. It is the ratio of total interest paid to the sum of deposits and debt securities. Profitability is captured by the RoA variable for the return on asset. Two variables are defined relative to capital requirements. First, $CapReq$ is defined as total capital requirements in percent of Risk Weighted Asset. From 2010 to 2013 capital requirements were limited to 8% of RWA. Since 2014, three buffers have been introduced leading to a maximum capital requirement of 16.5% under Pilar 1. Second, we define capital surplus ($CapSurp$) as the difference between capital and capital requirement over total assets. Finally, we use legal status of BHCs to define the business model of BHCs ($Businessmodel$) including banks, cooperative banks and specific financial institutions.

To ensure some degree of stability in our sample, we only keep BHCs that report all information for at least 3 consecutive years between 2010 and 2017. With yearly observations, our panel is unbalanced with a minimum of 24 BHCs in 2017 and a maximum of 29 BHCs in 2013.

2.3 Data analysis: introducing BHC complexity

Figure 1 pictures the weighted average of total affiliates by BHC from 2010 to 2017. On average, total affiliates decrease between 2010 and 2013 before recovering in the second half of the period. The fluctuations of total affiliates is mainly driven by affiliates located abroad, while affiliates located in France remain stable over the period. In addition, our data show a strong correlation between size and complexity. The largest BHCs are also the most complex.

[4] See Zimmer and McCauley [1991] for examples where the return on equity is used as a proxy of the cost of equity.

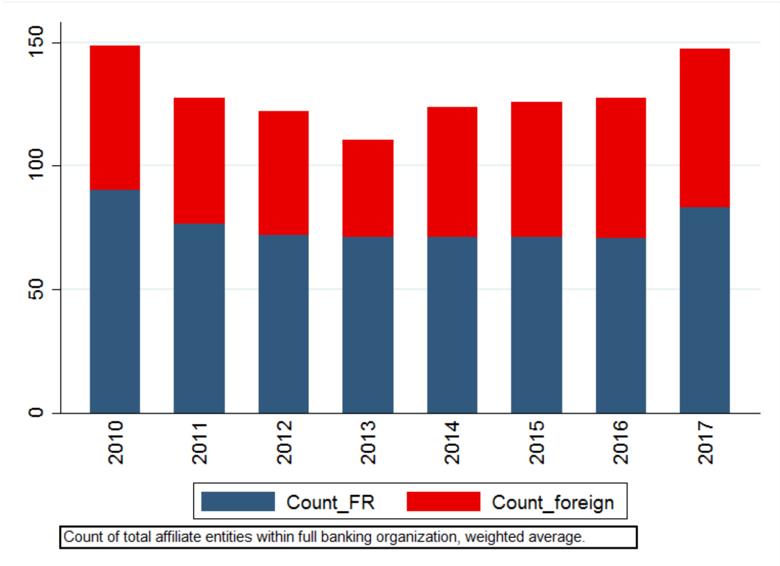


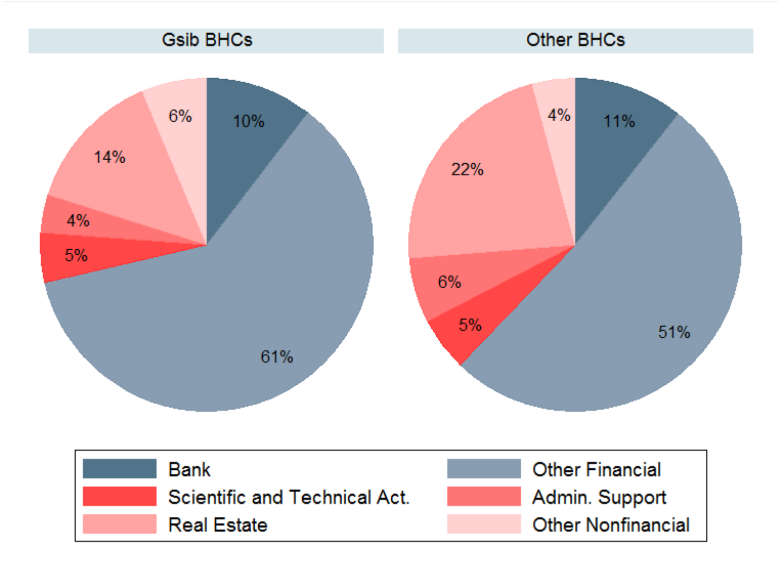
Figure 1: Total affiliates by BHC

Each bar sums the weighted average of total count of affiliates by BHC by year. The weighted average is computed based on the relative size of BHCs. Total count is then divided into two part, including affiliates located in France and affiliates located abroad.

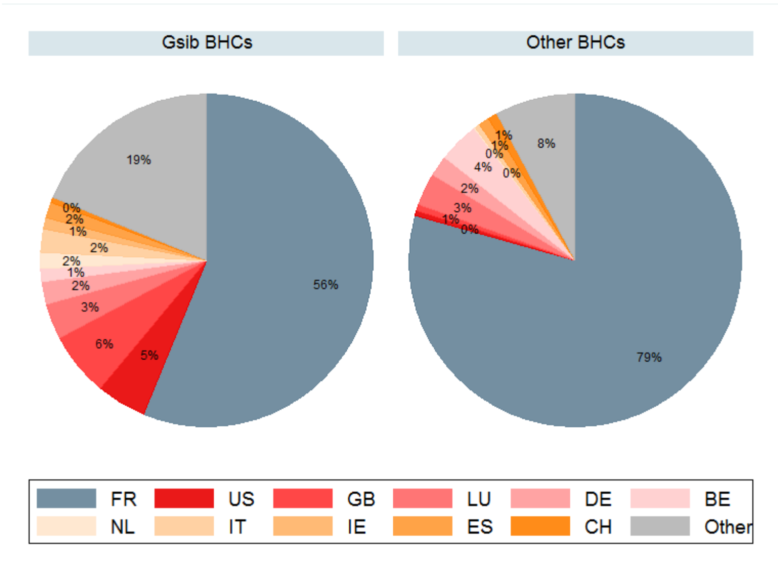
According to our data, around 80% of the total affiliates reported by all BHCs are in fact reported by systemic BHCs.[5] As reported in table 1, a system BHC counts on average 425 affiliates, a geographic location in 40 different countries and 7 different business types of affiliates. For a non-systemic BHC the picture is significantly different. On average, a non-systemic BHC counts 15 affiliates, a geographic location in less than three different countries and almost a single business activity. However, in each sub-group of BHCs, we still observe large heterogeneity in complexity measures.

The difference between systemic and non-systemic BHCs is not limited to the scale of complexity, it also concerns the composition and the variations of complexity. Figure 2 compares BHCs based on the breakdown of industries and countries in which BHCs are involved in. Regarding industries, if the shares of affiliates involved in banking activities are equal to 11% for

[5] We identify systemic BHCs as BHCs that have been reported as Gsib institutions at least once during the 2010-2017 period. In our sample, it concerns 5 systemic BHCs. We choose the Gsib classification because this indicator captures and translates the French specificity where the banking system is composed of two heterogeneous types of banks. Our interest focuses on this heterogeneity which goes beyond the difference in the systemic importance of BHCs.



(a) Structural complexity



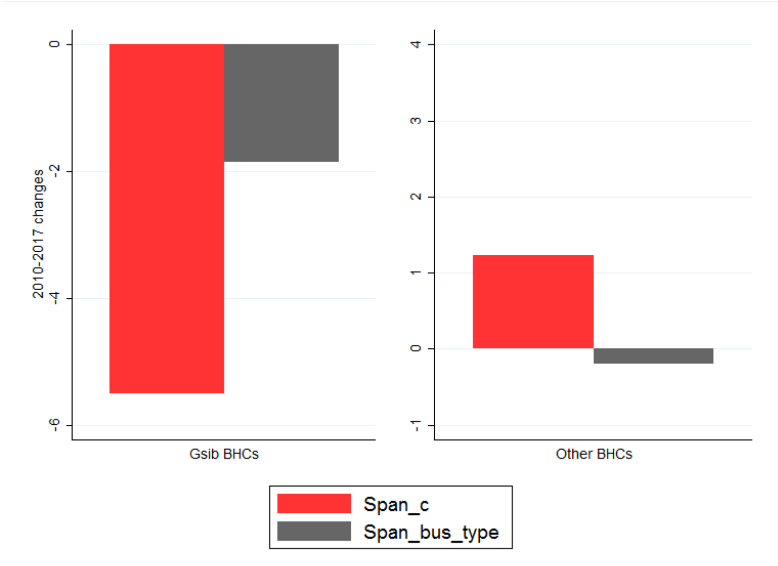
(b) Geographical complexity

Figure 2: Heterogeneous complexity profil of BHCs: Gsib and non-Gsib BHCs
Each pie details the average breakdown of complexity measures over the period 2010-2017 for systemic BHCs and other BHCs. Panel a) details structural complexity and reports the five main industries BHCs are active in. Panel b) focuses on geographical complexity.

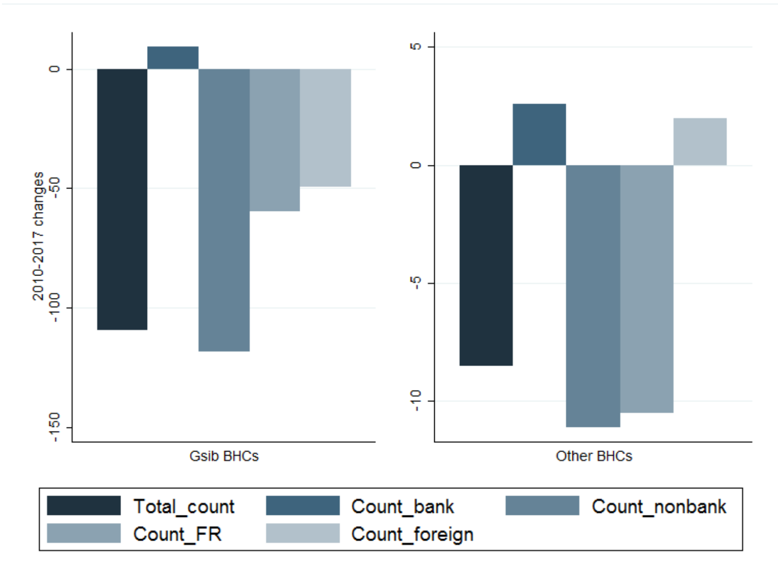
both categories of BHCs, the shares of affiliates involved in other financial activities are significantly different. On average over the period, 61% of affiliates of systemic BHCs are involved in other financial activities, meaning that almost 3/4 their affiliates are specialized in financial activities. For the other BHCs, the share of affiliates involved in other financial activities drops to 52%, implying a higher share of affiliates involved in non-financial activities than the share of systemic BHCs. Especially, the relatively small share of affiliates in other financial activities is compensated by a larger share of affiliates involved in real estate for the non-systemic BHCs. The significant share of affiliates in real estate is consistent with results from Goldberg and Meehl [2019] focusing on large US banks.

Turning to the breakdown of countries a BHC is active in, the conclusions are also quite different depending on BHCs. More than 3/4 of affiliates attached to non-systemic BHCs are located in France, compared to only 57% for systemic BHCs. More interestingly, the first two countries after France are the US and the UK for systemic BHCs, adding up to 10% of their affiliates. It only counts for 1% of the total affiliates of other BHCs. The graph finally tells us that non-systemic BHCs are more based in the European region compared to systemic BHCs. 20% of the locations includes other locations that are mainly non-European for systemic BHCs. The share drops to 9% for other BHCs.

Systemic and non-systemic BHCs are also different in the variation of their complexity measures. Figure 3 shows the variation of several complexity measures between 2010 and 2017. While both the number of countries and the number of industries a BHC is active in decrease for systemic BHCs over the period, the number of countries increases and the number of industries stays quite stable for other BHCs. This asymmetry in the international span of BHCs is also supported by results from Goldberg and Meehl [2019] where large US banks have decreased their international dimension from 2007 to 2017. Decomposing the decline in total affiliates also underlines the heterogeneous profile in BHCs. Regarding systemic BHCs, the decrease in total affiliates is essentially explained by a decrease in all categories of affiliates. For non-systemic BHCs, the decrease in non-bank affiliates is partially compensated by an increase in bank affiliates. Similarly, the reduction in French affiliates goes with a rise in foreign affiliates. All in all, the decrease in the complexity of systemic BHCs is mainly confirmed over the period, while the evolution of complexity of non-systemic BHCs is specific to each measure of complexity.



(a) Number of countries and business activities



(b) Number of affiliates

Figure 3: Changes in complexity: Gsib and non-Gsib BHCs

Each bar illustrates the average change in complexity measures between 2010 and 2017 for systemic BHCs and other BHCs.

The particular profile of systemic BHCs is also observed in major bank control variables. Table 1 reports statistics on major banking indicators. Systemic BHCs show larger leverage, capital requirement and surplus than non-systemic BHCs institutions. In addition, they are less risky than non-systemic BHCs, and both their cost of equity and debt are lower than those of the non-systemic BHCs.

{ *Insert table 1* }

3 Net impact on leverage of complexity

In this section, we assess the net impact of complexity on leverage. To do so, we follow the corporate finance literature (Rajan and Zingales [1995], Gropp et al. [2010]) on capital structure. It identifies size, profitability and risk as determinant of leverage. Size captures the potential implicit bail-out guarantee from the government. It decreases the cost of equity and increases the optimal leverage. Profitability is a good signal for investors. It decreases the cost of equity and rises optimal leverage. However, retain earnings is also the cheapest source of funding. Following the pecking order theory, profits would be preferred to external debt, implying a negative relationship between leverage and profit. Finally, risk increases the probability of failure and the cost of equity. Because complexity affects risk of BHCs, we introduce complexity as a fifth determinant of leverage. Considering the two heterogeneous sub-groups of BHCs (systemic and non-systemic BHCs), we also test for the non-monotonic relationship between leverage and complexity depending on the systemic importance(i.e Gsib status).

3.1 Net impact on leverage of complexity

As size and complexity are strongly correlated, omitting complexity while assessing the impact of size is misleading. Size would capture the effect of complexity and vice versa. Despite the positive correlation between size and complexity, our data still show heterogeneous complexity within each sub-groups of BHCs. Specification (1), (2) and (3) test the impact of size and complexity on leverage by either taking each determinant separately or simultaneously.

Based on the corporate finance literature, we regress the lag of BHC i's characteristics on BHC i's leverage. For each specification, we control for other determinants of leverage including risk (natural logarithm of RWA_dens) and profitability (RoA). To take into account the fact that banks are regulated, we control for capital requirements ($Capreq$). Several dummy variables are introduced to control for time-invariant characteristics of BHCs, including the nationality (FR) and the business model characteristics ($Businessmodel$). Time fixed effects are introduced to control for global shocks that affect all banks and other general changes concerning data.

The first specification focuses on the impact of size on leverage when complexity measures are not included in the specification.

$$Leverage_{i,t} = \alpha + \beta_1 \ Size_{i,t-1} + \beta_2 \ BankControls_{i,t-1} + FE_t + u_{i,t} \tag{1}$$

Where :

$$BankControls : \{RWA\_Dens;\ RoA;\ Capreq\ ;\ FR;\ Businessmodel\}$$

Specification 2 replaces size with the different measures of complexity by BHC i, including the count of total affiliates ($total\_count$), the number of countries affiliates are spanned in ($span\_c$), and the number of different sectors the affiliates are involved in ($span\_bus\_type$).

$$Leverage_{i,t} = \alpha + \beta_1 \ Complex_{i,t-1} + \beta_2 \ BankControls_{i,t-1} + FE_t + u_{i,t} \tag{2}$$

Where :

$$Complex : \{total\_count;\ span\_c;\ span\_bus\_type\}$$

Specification 3 analyzes simultaneously the role of size and complexity in order to isolate the independent effect of these two key risk factors on capital structure.

$$\begin{aligned} Leverage_{i,t} = \alpha + \beta_1 \ Size_{i,t-1} + \beta_2 \ Complex_{i,t-1} + \beta_3 \ BankControls_{i,t-1} \\ + FE_t + u_{i,t} \end{aligned} \tag{3}$$

Results on the net impact of size and complexity on leverage from specifications (1) and (2) are detailed in table 2 columns (1) to (4). The coefficient of size is positive and significant for all specifications, suggesting that the largest BHCs enjoy an implicit bail-out guarantee. For the different measures of complexity, coefficients are negative and significant, implying that more complexity goes with lower leverage. These results on complexity suggest that complexity - both geographical and structural - increases risk and capital cost of BHCs. It support previous results from Buch et al. [2013], Gulamhussen et al. [2013], Goetz et al. [2013], De Jonghe [2010] where complexity increases risk.

{ *Insert table 2* }

When size and complexity are simultaneously included in the regression as detailed in specification (3), we observe a general increase in the absolute value of coefficients as reported in columns (5), (6) and (7) of table 2. In addition to that, coefficients are now strongly significant. Therefore, empirical analyses that omit to control for size of BHCs when assessing the complexity impact on leverage are misleading. Size and complexity are strongly correlated; however, they also complement each other. In order to isolate the net impact of each determinant, once needs to introduce both size and complexity simultaneously.

3.2 A non-monotonic relationship: the Gsib status

As underlined previously, our sample can be divided into two groups. The first group includes BHCs that have been identified as Gsib institutions between 2010 and 2017. It consists of large and systemic BHCs. Other smaller BHCs constitute the second group. Because of their systemic dimension, banking regulation had introduced in 2014 supplementary capital requirements to secure the stability of systemic BHCs.[6] In other words, their capital structure is more constrained than the capital structure of non-systemic BHCs. However, we have two main reasons to believe that complexity is still relevant in the definition of leverage of BHCs. First, capital requirements introduced by banking regulation set up a minimum level of capital, leaving some room for the upper bound of capital. As documented in table 1, all systemic BHCs report a capital surplus, implying that leverage is not limited only by bank regulations. Second, complexity measures add information on BHCs. As Gsib identification is mainly based on BHCs' size, we observe heterogeneity in complexity variables even within sub-group of BHCs (details in table 1).

[6] Details on Gsib BHCs capital requirements are available here:`https://www.esrb.europa.eu/national_policy/systemically/html/index.en.html`

In addition to the regulatory dimension, we believe that the impact of complexity on leverage is non-monotonic and depends on the Gsib status. The Gsib status includes the most complex BHCs over the period. Thank to their experiment, they have developed specific skills to manage risks and to extract benefits from complexity. Following the literature on internationalization and complexity, the early stage of complexity is especially subject to the introduction of new costs while the benefits usually compensate costs afterwards.

To test for the simultaneous effects of complexity and Gsib status on leverage, we follow a three steps approach. First, specification 4 introduces a dummy variable Gsib ($Gsib$) to test the Gsib hypothesis independently of complexity. Second, we introduce simultaneously complexity variables and the $Gsib$ variable in specification 5. Finally, specification 6 adds an interaction variable between the different complexity measures and the dummy $Gsib$ to test the conditional impact of complexity and Gsib status on leverage.

$$Leverage_{i,t} = \alpha + \beta_1\ Size_{i,t-1} + \beta_2\ Gsib + \beta_3\ BankControls_{i,t-1} + FE_t + u_{i,t} \tag{4}$$

$$\begin{aligned} Leverage_{i,t} = \alpha &+ \beta_1\ Size_{i,t-1} + \beta_2\ Complex_{i,t-1} + \beta_3\ Gsib + \beta_4\ BankControls_{i,t-1} \\ &+ FE_t + u_{i,t} \end{aligned} \tag{5}$$

$$\begin{aligned} Leverage_{i,t} = \alpha &+ \beta_1\ Size_{i,t-1} + \beta_2\ Complex_{i,t-1} + \beta_3\ (Complex_{i,t-1}.Gsib) + \beta_4\ Gsib \\ &+ \beta_5\ BankControls_{i,t-1} + FE_t + u_{i,t} \end{aligned} \tag{6}$$

Table 3 details results for each specification and each complexity variable. The coefficient of $Gsib$ in column (1) is negative and significant. Independently of complexity, being a Gsib BHC leads to lower leverage than the leverage of other BHCs. Columns (2), (3) and (4) report results when complexity and Gsib status are included simultaneously. The coefficient of the Gsib dummy becomes insignificant, while coefficients of each complexity measure are negative and significant. These results picture the strong correlation between complexity and Gsib status. Therefore, it underlines the necessity to split the effect of each variable conditional to the other.

{ *Insert table 3* }

Columns (5), (6) and (7) of table 3 document results on the conditional impact of complexity and Gsib status on leverage. The coefficients of both complexity measures and Gsib dummy are negative and significant, while coefficients of the interaction term are positive and significant. Our results confirm the non-monotonic relationship between complexity and leverage. For non Gsib BHCs, the impact of complexity on risk is negative. It suggests that complexity leads to higher risk for this sub-group of BHCs. This negative impact of complexity on leverage is removed for Gsib BHCs. For each measure of complexity, the sum of the coefficients is not significantly different from zero. This interesting result suggests that, compared to non Gsib BHCs, complexity does not introduce risk, or that investors do not price the risk associated to complexity for this specific group of BHCs. Because Gsib BHCs are the most complex over the period, they may have developed specific skills to manage risk better than non Gsib BHCs. Therefore, our results supports the previous results from the literature, including Liu et al. [2015], Buch et al. [2013], Cetorelli and Traina [2018], where the negative effect of complexity on risk is especially observed at the early stage of complexity.

4 Funding channels of complexity

Our results show a negative relationship between leverage and complexity, suggesting that complexity increases risk. This section aims at testing several underlying hypotheses on the funding channels of complexity and risk.

4.1 Complexity and risk: a cross section analysis

On the one hand, complexity reduces risk through diversification benefit. On the other hand, it introduces new costs including monitoring and agency costs. The net impact of complexity on risk is then uncertain. To measure risk of BHCs, we use the natural logarithm of the RoA standard deviation. This measure captures the riskiness of BHCs observable by all investors over the period.

To test whether complexity is associated to additional risk, we introduce simultaneously size and complexity as explanatory variables. Our previous results show that the two variables bring complementary information on BHCs. The cross-section regression testing for the correlation between complexity and risk is detailed in specification 7.

$$Risk_i = \alpha + \beta_1 Size_i + \beta_2 Complex_i + u_i \tag{7}$$

Resulting correlations are documented in table 4. Size and risk are negatively correlated while complexity and risk are positively correlated. Our results hold for all measures of complexity. It supports the idea that risk decreases with size but increases with complexity.

{ *Insert table 4* }

These additional results comfort previous results from Buch et al. [2013], Gulamhussen et al. [2013], Goetz et al. [2013] and our main conclusion on leverage and complexity.

4.2 Capital surplus and complexity

Capital is natural cushion against risk. To cover risk, banking regulation requires BHCs to hold a minimum of capital relative to their risk exposures. Based on our data and despite the cost of capital, BHCs usually hold more capital than the minimum capital required, leading to a capital surplus. On average over the period, capital surplus reaches 2% and 18% of total assets for the Gsib and non Gsib BHCs, respectively.

Because complexity goes with risk and negatively impacts leverage, we believe that complexity increases capital surplus in the first place. To test this hypothesis, we introduce risk, size, Gsib status and complexity as explanatory variables of capital surplus ($CapSurp$) in specification 8. As for previous analysis on leverage, we control for the nationality and the business model of BHCs. Time fixed effect are also introduced.

$$\begin{aligned} CapSup_{i,t} =& \alpha + \beta_1 \; Risk_{i,t-1} + \beta_2 \; Size_{i,t-1} + \beta_3 \; Gsib_i + \beta_4 \; Complex_{i,t-1} \\ & + \beta_5 \; BankControls_{i,t-1} + FE_t + u_{i,t} \end{aligned} \tag{8}$$

Where :

$$BankControls : \{FR;\ Businessmodel\}$$

Results are reported in table 5. Focusing in column (1), the coefficient of risk exposure is positive and significant, meaning that higher risk on assets leads to more capital surplus. It may express the fact that investors are sensitive to asset risk exposure and ask BHCs to hold additional capital surplus. Regarding size, the coefficient is negative and significant. Capital surplus of BHCs decreases with size, suggesting that investors believe in an implicit bail-out guarantee for large BHCs. The coefficient of the Gsib dummy is positive and significant in column (1). Being a Gsib BHC implies larger capital surplus than non Gsib status. This result may translate the risk aversion of investors relative to the systemic importance.

Columns (2) to (4) report results when complexity is introduced in the specification of capital surplus. The coefficient is positive and significant except when complexity is related to the geographic location spanned by affiliates of BHCs. It suggests that complexity of BHCs increases capital surplus in response to additional risk introduced by complexity. However, the coefficient of Gsib status becomes insignificant when complexity consists of total affiliates.

{ *Insert table 5* }

Our results suggest that this relationship depends on Gsib importance, especially if the measure of complexity is the number of affiliates reported by BHCs. To test the non-monotonic relationship between capital surplus and complexity relative to Gsib status, we introduce an interaction variable between our measures of complexity and the dummy variable *Gsib* in specification 9.

$$\begin{aligned} CapSup_{i,t} = \alpha + \beta_1\ Risk_{i,t-1} + \beta_2\ Size_{i,t-1} + \beta_3\ Gsib_i + \beta_4\ Complex_{i,t-1} \\ + \beta_5\ (Complex_{i,t-1}.Gsib) + \beta_6\ BankControls_{i,t-1} + FE_t + u_{i,t} \end{aligned} \tag{9}$$

Columns (5), (6) and (7) of table 5 confirm the non-monotonic relationship between complexity and capital surplus for all measures of complexity. The coefficients of complexity variables are positive and significant. It validates the positive effect of complexity on capital surplus for non

Gsib BHCs. Because complexity goes with risk, investors may ask non Gsib BHCs to hold additional capital surplus. This additional capital surplus then limits leverage of non Gsib BHCs. Regarding Gsib BHCs, the positive effect of complexity on capital surplus is still observable when complexity consists of total affiliates. The sum of coefficients is positive and significant. However, the effect of complexity is removed when complexity is attached to geographic location and business type. The asymmetry in results might come from the fact that investors do not price complexity risk similarly for Gsib BHCs and non Gsib BHCs, or because they assume that capital requirements of Gsib BHCs is sufficient in regards to their complexity.

To summarize, complexity has an effect on the volume of capital hold by BHCs. For non Gsib BHCs, complexity increases capital surplus which limits leverage afterwards. For Gsib BHCs, this effect is not that strong.

4.3 Funding costs of complexity: cost of equity and cost of debt

4.3.1 Cost of equity

Capital is natural cushion against risk, but it is also the most expensive source of funding. To capture the mechanism through which complexity affects leverage, we extend the analysis to the cost of equity of BHCs. Our previous results show that complexity goes with risk and that complex BHCs hold additional capital surplus, especially for non Gsib BHCs. However, whether investors price this additional risk or not is not certain. Knowing whether this additional capital surplus goes hand in hand with higher cost than without complexity is decisive to understand the relationship between leverage and complexity.

Following the corporate finance literature, the cost of equity mainly depends on the probability of failure of the BHC and its leverage. The highest the leverage, the lowest the probability that shareholders recover part of their investment in case of liquidation. Leverage leads to an increase of the cost of equity. The probability of failure depends on risk, but also on whether BHCs are sufficiently capitalized to cope shocks. Specification 10 introduces leverage, risk, capital surplus, Gsib status and complexity as determinants of cost of equity (CoE). Time fixed effects and previous control variables including nationality and business model are also included in our specification.

$$
\begin{aligned}
CoE_{i,t} =& \alpha + \beta_1\ Leverage_{i,t-1} + \beta_2\ Risk_{i,t-1} + \beta_3\ CapSurp_{i,t-1} + \beta_4\ Gsib_i + \beta_5\ Complex_{i,t-1} \\
& + \beta_6\ BankControls_{i,t-1} + FE_t + u_{i,t} \qquad (10)
\end{aligned}
$$

Results in column (1) of table 6 confirm the positive impact of leverage and risk on the cost of equity. However, the coefficient of complexity is positive but insignificant for all definitions of complexity. It suggests that, overall, complexity does not affect BHCs' cost of equity.

{ *Insert table 6* }

Whether investors price risk introduced by complexity or not may depend on the Gsib status. As mentioned previously, Gsib BHCs are the most complex over the period. Investors may consider that they have developed specific skills to manage risk. Therefore, the impact of complexity on the cost of equity of BHCs may be non-monotonic. To test this hypothesis, we introduce an interaction variable between complexity measures and the Gsib dummy in specification 11.

$$
\begin{aligned}
CoE_{i,t} =& \alpha + \beta_1\ Leverage_{i,t-1} + \beta_2\ Risk_{i,t-1} + \beta_3\ Gsib_i + \beta_4\ CapSurp_{i,t-1} + \beta_5\ Complex_{i,t-1} \\
& + \beta_6\ (Complex_{i,t-1}.Gsib) + \beta_7\ BankControls_{i,t-1} + FE_t + u_{i,t} \qquad (11)
\end{aligned}
$$

Results are reported in columns (5), (6) and (7) of table 6. Except when complexity is defined through business types spanned by affiliates, our results confirm that complexity implies higher cost of equity for non Gsib BHCs. Combining these results with previous one, it underlines how relevant complexity is for leverage. Because of it, non-Gsib BHCs hold more capital surplus than Gsib BHCs and this capital is more costly than the capital of Gsib BHCs. All in all, our results support the negative relationship between leverage and complexity.

Regarding Gsib importance, all coefficients of the Gsib dummy are not significantly different from 0. Compared to previous results on capital surplus, it shows that Gsib BHCs are subject to additional capital constraints in terms of volume but not in terms of costs. For non-Gsib BHCs, it is both the volume and the cost of equity that are at stake.

4.3.2 Cost of debt

In addition to the cost of equity, complexity may impact the cost of debt. Depending on the number of geographic locations or the number of business activities spanned by affiliates, complexity may offer new funding opportunities, altering the cost of debt of BHCs. In that case, complexity introduces funding benefits that support leverage. Testing whether complexity affects the cost of debt of BHCs or not extends the analysis on leverage and complexity and it brings a close to the funding costs of complexity.

To test the hypothesis of funding benefits, we introduce specification 12 where leverage, risk, capital surplus, Gsib status and complexity are explanatory variables of the cost of debt (CoD). Control variables include nationality and business model to capture time-invariant characteristics of BHCs. Time fixed effects controls for global shocks that affect all banks and other general changes concerning data.

$$\begin{aligned} CoD_{i,t} =& \alpha + \beta_1 \ Leverage_{i,t-1} + \beta_2 \ Risk_{i,t-1} + \beta_3 \ CapSurp_{i,t-1} + \beta_4 \ Gsib_i + \beta_5 \ Complex_{i,t-1} \\ &+ \beta_6 \ BankControls_{i,t-1} + FE_t + u_{i,t} \end{aligned} \tag{12}$$

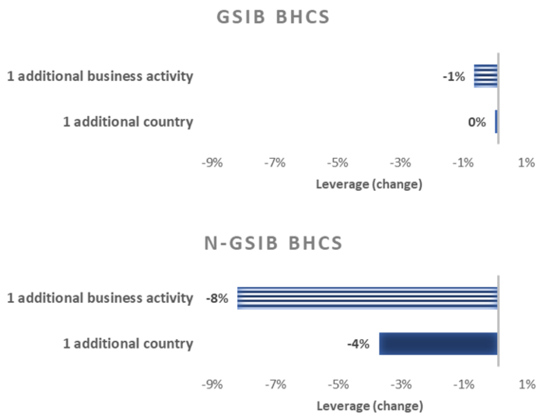
Results are reported in columns (1) to (4) of table 7. Our results first show that capital surplus improves funding costs relative to debt. BHCs that are better capitalized benefit from lower costs of debt than BHCs with low level of capital surplus. Turning to complexity, only complexity relative to business activities is relevant. The coefficient is negative and significant, supporting the idea that many business types offer funding opportunities.

{ *Insert table 7* }

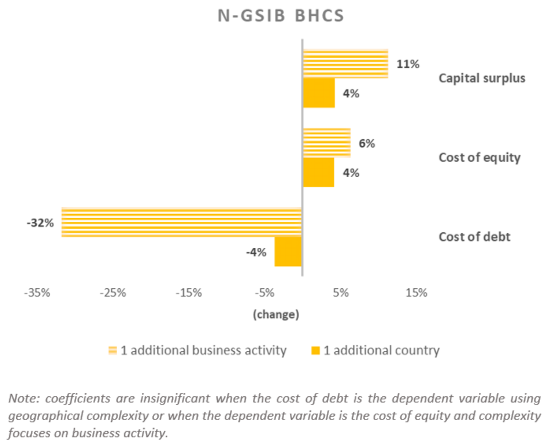
In specification 13, we test for the conditional effect of complexity on the cost of debt relative to Gsib status. To do so, we introduce an interaction variable between complexity and the Gsib dummy variable.

$$\begin{aligned} CoD_{i,t} =& \alpha + \beta_1 \ Leverage_{i,t-1} + \beta_2 \ Risk_{i,t-1} + \beta_3 \ CapSurp_{i,t-1} + \beta_4 \ Gsib_i + \beta_5 \ Complex_{i,t-1} \\ &+ \beta_6 \ (Complex_{i,t-1}.Gsib) + \beta_7 \ BankControls_{i,t-1} + FE_t + u_{i,t} \end{aligned} \tag{13}$$

Results are detailed in columns (5), (6) and (7) of table 7. The coefficient of the complexity variable relative to business types is still negative and significant. It confirms the funding benefit of complexity for non-Gsib BHCs. In regards to previous results on non-Gsib BHCs, complexity due to many business activities increases risk and capital surplus, but it introduces a funding benefit. However, the funding benefit is not sufficient to overtake costs. All in all, leverage depends negatively on complexity. Turning to Gsib BHCs, the coefficient of the interaction variable between the Gsib dummy and complexity is positive and significant. The funding opportunity is removed for Gsib BHCs (the sum of coefficients is not significantly different from 0).



(a) Impact of complexity on leverage



(b) The funding channels of complexity

Figure 4: Heterogeneity in bank leverage: the funding channels of complexity

Two types of complexity are considered in this figure: geographical complexity (number of countries) and structural complexity (number of different business activities). The left panel shows that higher complexity significantly reduces leverage for non-systemic BHCs ; the result does not hold for systemic BHCs, showing heterogeneity in the impact of complexity. The right panel shows that this result for non-systemic BHCs is driven by higher capital surplus, higher cost of equity, and lower cost of debt when complexity increase.

Figure 4 summarizes the main results of the paper where geographical and business complexity are considered. Expanding business activity by one additional activity significantly decreases expected leverage by 8% for non-systemic BHCs. For systemic BHCs, the decrease is limited to 1% and it is insignificant. Our results clearly underline an asymmetry between Gsib BHCs and other BHCs. For Gsib BHCs, complexity does not significantly increase capital surplus and cost of equity, nor decreases cost of debt. Compared to non-Gsib BHCs, where complexity implies higher capital surplus and higher cost of equity, it suggests that investors do not price risk introduced by complexity.

Overall, complexity of systemic BHCs does not affect their leverage despite potential risks. Two main explanations might be at stake. First, investors may assume that Gsib BHCs have developed specific skills to manage their own risk, while non-Gsib BHCs are at the beginning of their development. Second, investors may consider that capital requirements specific to Gsib BHCs are sufficient to cover risks introduced by complexity. For non-Gsib BHCs, the negative impact of complexity on leverage is explained by an increase in capital surplus and cost of equity and a limited funding opportunity.

5 Conclusion

This paper provides novel facts on bank complexity for BHCs located in France between 2010 and 2017. It shows the strong heterogeneity between the large and systemic BHCs and other BHCs where the latter is less complex both in terms of geographical and structural complexity than systemic BHCs. The heterogeneity in complexity does not only rely on the scale of complexity, but also on the adjustment of complexity over the period. Since 2010, systemic BHCs have decreased their complexity while non-systemic BHCs have expend their activities both in terms of geographical locations and total banking affiliates. Because systemic BHCs and non-systemic BHCs also differ in their size and maturity, their relation to risk is more complex than a monotonic relationship.

Our results first indicate that size, complexity and systemic importance add information on BHCs. Because they complement each other, omitting one of these dimensions leads to misleading conclusions on the financial stability of banks. Considering this, complexity implies lower leverage for non-systemic BHCs than for systemic BHCs. It suggests that monitoring costs and agency problems outweigh diversification benefits for non-systemic BHCs. All in all, our results confirm the non-monotonic relationship between leverage and complexity. Then, we extend our analysis to the funding channels of complexity to explain our first results. We identify the determinants of capital surplus and funding costs, and we confirm the asymmetry between systemic and non-systemic BHCs. Non-systemic BHCs are subject to additional capital constrains in terms of volume and costs, while systemic BHCs are only concerned by volumes and to a lesser extend than non-systemic BHCs. These additional capital constrains limit the development of leverage in the first place, especially as complexity implies limited benefits with regards to the cost of debt.

This paper provides interesting insights on the relationship between complexity and risk. It suggests that investors price additional risk coming from complexity, especially for non systemic BHCs. However, it does not prove that the risk assessment done by investors is the correct one. Therefore, additional research is needed to measure the real effect of complexity on risk to go beyond the risk perceived by investors. Doing so, it would help banking supervisors to identify which part of risk is not covered by investors and define the appropriate regulatory tools for banking stability.

Table 1: Heterogeneous profil of BHCs: Gsib and non-Gsib BHCs

Results are based on the BHC average value of each variable from 2010 to 2017. It describes the cross-section heterogeneity between Gsib BHCs and other BHCs and between BHCs within each type of category (Gsib versus others).

	Mean	**Std. Dev.**	**Min.**	**Max.**	**N**
Gsib BHCs					
Leverage	21.239	1.77	18.93	23.86	5
Std. Dev.(RoA)	0.001	0.001	0.001	0.002	5
Cap. Requirement	8.409	0.128	8.329	8.625	5
Cap. Surplus	2.151	0.266	1.88	2.566	5
CoE	5.654	1.046	4.281	7.079	5
CoD	1.89	0.006	1.05	2.76	5
Roa	0.276	0.046	0.218	0.34	5
Total_count	424.925	201.134	68.00	549.50	5
Span_c	39.308	21.075	4.667	60.50	5
Span_bus_type	7.350	3.624	1.00	10.125	5
Other BHCs					
Leverage	13.40	13.25	1.06	52.63	35
Std. Dev.(RoA)	0.01	0.02	0.00	0.08	35
Cap. Requirement	8.24	0.41	8.00	9.50	35
Cap. Surplus	18.23	24.68	-0.99	83.47	35
CoE	6.20	6.95	-10.70	22.45	35
CoD	33.9	1.34	0.00	81.10	35
Roa	1.70	3.19	-3.12	13.06	35
Total_count	14.66	59.32	1.00	353.38	35
Span_c	2.49	4.02	1.00	21	35
Span_bus_type	1.84	1.23	1.00	7.75	35

Table 2: Net impact of BHCs size and complexity on leverage

$$Leverage_{i,t} = \alpha + \beta_1\ Size_{i,t-1} + \beta_2\ BankControls_{i,t-1} + FE_t + u_{i,t}$$
$$Leverage_{i,t} = \alpha + \beta_1\ Complex_{i,t-1} + \beta_2\ BankControls_{i,t-1} + FE_t + u_{i,t}$$
$$Leverage_{i,t} = \alpha + \beta_1\ Size_{i,t-1} + \beta_2\ Complex_{i,t-1} + \beta_3\ BankControls_{i,t-1} + FE_t + u_{i,t}$$

(1), (2), (3) and (4) test the net impact of size or complexity separately while (5) (6) and (7) introduce simultaneously size and complexity measures as determinants of leverage. Risk is defined as the RWA density. Data cover BHCs from 2010 to 2017. Standard errors are robust and control variables including dummies for FR and $Businessmodel$ are not reported in this table. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Size_{t-1}$	0.30*				0.84***	0.76***	0.80***
	(0.18)				(0.19)	(0.19)	(0.22)
$Total\_count_{t-1}$		-0.01**			-0.01***		
		(0.00)			(0.00)		
$Span\_c_{t-1}$			-0.04**			-0.11***	
			(0.02)			(0.03)	
$Span\_bus\_type_{t-1}$				-0.32***			-0.83***
				(0.12)			(0.19)
$Risk_{t-1}$	-15.96***	-16.90***	-16.84***	-16.85***	-15.41***	-15.45***	-15.37***
	(1.25)	(1.10)	(1.10)	(1.10)	(1.16)	(1.19)	(1.19)
RoA_{t-1}	81.25***	85.19***	84.84***	84.92***	81.32***	80.86***	80.80***
	(14.07)	(14.11)	(14.07)	(13.98)	(13.28)	(13.23)	(12.74)
$Const.$	-14.25	-11.16	-11.43	-10.08	-20.16*	-19.79*	-16.97
	(12.36)	(11.86)	(11.77)	(11.83)	(12.01)	(11.61)	(11.95)
Adjusted R^2	0.72	0.72	0.72	0.72	0.73	0.73	0.73
N	169	169	169	169	170	170	170

Table 3: Conditional impact of complexity and Gsib status on leverage

$$Leverage_{i,t} = \alpha + \beta_1 \; Size_{i,t-1} + \beta_2 \; Gsib + \beta_3 \; BankControls_{i,t-1} + FE_t + u_{i,t}$$
$$Leverage_{i,t} = \alpha + \beta_1 \; Size_{i,t-1} + \beta_2 \; Gsib + \beta_3 \; Complex_{i,t-1} + \beta_4 \; BankControls_{i,t-1} + FE_t + u_{i,t}$$
$$Leverage_{i,t} = \alpha + \beta_1 \; Size_{i,t-1} + \beta_2 \; Gsib + \beta_3 \; Complex_{i,t-1} + \beta_4 \; (Complex_{i,t-1}.Gsib) + \beta_5 \; BankControls_{i,t-1} + FE_t + u_{i,t}$$

Risk is defined as the RWA density. Data cover BHCs from 2010 to 2017. Standard errors are robust and control variables including dummies for FR and $Businessmodel$ are not reported in this table. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Size_{t-1}$	0.62***	0.83***	0.75***	0.84***	1.02***	0.96***	0.93***
	(0.20)	(0.20)	(0.19)	(0.21)	(0.19)	(0.19)	(0.22)
$Gsib$	-4.04***	0.93	0.27	-1.33	-8.51***	-6.53***	-7.69***
	(1.32)	(2.01)	(2.66)	(1.60)	(2.72)	(2.24)	(2.85)
$Total\_count_{t-1}$		-0.02***			-0.03***		
		(0.00)			(0.01)		
$Total\_count_{t-1}.Gsib$					0.03***		
					(0.01)		
$Span\_c_{t-1}$			-0.12**			-0.51***	
			(0.05)			(0.15)	
$Span\_c_{t-1}.Gsib$						0.49***	
						(0.15)	
$Span\_bus\_type_{t-1}$				-0.71***			-1.12***
				(0.25)			(0.34)
$Span\_bus\_type_{t-1}.Gsib$							0.96**
							(0.42)
$Risk_{t-1}$	-15.80***	-15.40***	-15.44***	-15.38***	-15.35***	-15.13***	-15.35***
	(1.18)	(1.18)	(1.22)	(1.19)	(1.15)	(1.26)	(1.18)
RoA_{t-1}	81.93***	81.34***	80.86***	80.92***	80.83***	79.57***	80.15***
	(13.57)	(13.33)	(13.27)	(12.81)	(13.30)	(13.48)	(12.69)
$CapReq_{t-1}$	155.69	150.77	159.59	134.29	145.10	187.54	125.85
	(141.89)	(139.37)	(135.46)	(138.45)	(135.44)	(116.28)	(135.35)
$Const.$	-17.65	-20.11*	-19.80*	-17.71	-24.18*	-26.55**	-19.65
	(11.99)	(12.05)	(11.63)	(11.94)	(12.26)	(10.48)	(12.26)
Adjusted R^2	0.73	0.73	0.73	0.73	0.74	0.74	0.73
N	169	170	170	170	170	170	170
Sum interaction Comp.					0.00	-0.03	-0.16
					(0.01)	(0.04)	(0.25)
Sum interaction Gsib					-8.48***	-6.04***	-6.73***
					(2.71)	(2.16)	(2.49)

Table 4: Bank risk and complexity: cross-section evidence

$$Risk_i = \alpha + \beta_1 Size_i + \beta_2 Complex_i + u_i$$

Risk is defined as the natural logarithm of RoA standard deviation. Results are based on the BHC average value of each variable from 2010 to 2017. It uses the cross-section heterogeneity between BHCs. ‡ $p < 0.11$; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Size	-0.41***	-0.38***	-0.41***	-0.39***	-0.40***	-0.39***	-0.41***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
$Total\_count$	0.00**						
	(0.00)						
Count_bank		0.01*					
		(0.01)					
Count_nonbank			0.00**				
			(0.00)				
Count_foreign				0.01**			
				(0.00)			
Count_FR					0.00**		
					(0.00)		
$Span\_c$						0.03**	
						(0.01)	
Span_bus_type							0.22***
							(0.08)
Const.	0.11	-0.28	0.13	-0.09	0.01	-0.19	-0.14
	(0.88)	(0.87)	(0.88)	(0.85)	(0.88)	(0.86)	(0.77)
Adjusted R^2	0.56	0.53	0.56	0.55	0.55	0.54	0.58
N	40	40	40	40	40	40	40

Table 5: Bank capital surplus and complexity

$$CapSup_{i,t} = \alpha + \beta_1\ Risk_{i,t-1} + \beta_2\ Size_{i,t-1} + \beta_3\ Gsib_i + \beta_4\ Complex_{i,t-1} + \beta_5\ BankControls_{i,t-1} + FE_t + u_{i,t}$$

$$CapSup_{i,t} = \alpha + \beta_1\ Risk_{i,t-1} + \beta_2\ Size_{i,t-1} + \beta_3\ Gsib_i + \beta_4\ Complex_{i,t-1} + \beta_5\ (Complex_{i,t-1}.Gsib) + \beta_6\ Gsib + \beta_7\ BankControls_{i,t-1} + FE_t + u_{i,t}$$

Risk is defined as the RWA density. Data cover BHCs from 2010 to 2017. Standard errors are robust and control variables including dummies for FR and $Businessmodel$ are not reported in this table. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Risk_{i,t-1}$	6.30**	9.19***	9.89***	9.30***	5.60**	5.50**	5.72**
	(2.51)	(2.55)	(2.47)	(2.62)	(2.61)	(2.65)	(2.63)
$Size_{t-1}$	-3.38***	-3.83***	-3.36***	-3.75***	-4.02***	-3.82***	-3.87***
	(0.77)	(0.83)	(0.76)	(0.86)	(0.85)	(0.86)	(0.87)
$Gsib$	14.93***	3.85	9.71***	8.21***	17.75***	17.09***	21.02***
	(3.58)	(2.48)	(3.13)	(2.75)	(5.01)	(4.88)	(6.35)
$Total\_count_{t-1}$		0.03***			0.05***		
		(0.01)			(0.01)		
$Span\_c_{t-1}$			0.12			0.77**	
			(0.08)			(0.30)	
$Span\_bus\_type_{t-1}$				1.36**			2.06**
				(0.67)			(0.94)
$Total\_count_{t-1}.Gsib$					-0.04***		
					(0.01)		
$Span\_c_{t-1}.Gsib$						-0.70**	
						(0.30)	
$Span\_bus\_type_{t-1}.Gsib$							-1.73*
							(0.91)
$Const.$	82.16***	74.83***	69.06***	71.71***	87.62***	84.42***	82.19***
	(11.05)	(13.80)	(13.03)	(13.31)	(10.45)	(10.32)	(9.65)
Adjusted R^2	0.58	0.45	0.44	0.45	0.60	0.59	0.59
N	169	169	169	169	169	169	169
Sum interaction Comp.					0.01**	0.07	0.33
					(0.01)	(0.05)	(0.30)

Table 6: Bank cost of equity and complexity

$$CoE_{i,t} = \alpha + \beta_1\ Leverage_{i,t-1} + \beta_2\ Risk_{i,t-1} + \beta_3\ CapSurp_{i,t-1} + \beta_4\ Gsib_i + \beta_5\ Complex_{i,t-1} + \beta_6\ BankControls_{i,t-1} + FE_t + u_{i,t}$$

$$CoE_{i,t} = \alpha + \beta_1\ Leverage_{i,t-1} + \beta_2\ Risk_{i,t-1} + \beta_3\ CapSurp_{i,t-1} + \beta_4\ Gsib_i + \beta_5\ Complex_{i,t-1} + \beta_6\ (Complex_{i,t-1}.Gsib) + \beta_7\ BankControls_{i,t-1} + FE_t + u_{i,t}$$

Risk is defined as the RWA density. Data cover BHCs from 2010 to 2017. Standard errors are robust and control variables including dummies for FR and $Businessmodel$ are not reported in this table. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Leverage_{t-1}$	0.25**	0.25**	0.25***	0.25**	0.26**	0.26***	0.25**
	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)
$Risk_{t-1}$	7.27***	7.30***	7.24***	7.31***	7.46***	7.41***	7.35***
	(1.92)	(1.93)	(1.92)	(1.93)	(1.98)	(1.92)	(1.97)
$CapSurp_{t-1}$	0.04	0.04	0.04	0.04	0.04	0.04	0.04
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
$Gsib$	0.13	-1.22	-2.64	-1.51	1.23	0.59	-0.41
	(0.85)	(1.31)	(2.05)	(1.41)	(2.29)	(1.92)	(2.51)
$Total\_count_{t-1}$		0.00			0.01*		
		(0.00)			(0.00)		
$Span\_c_{t-1}$			0.07			0.26**	
			(0.05)			(0.11)	
$Span\_bus\_type_{t-1}$				0.32			0.39
				(0.25)			(0.35)
$Total\_count_{t-1}.Gsib$					-0.01		
					(0.00)		
$Span\_c_{t-1}.Gsib$						-0.24**	
						(0.11)	
$Span\_bus\_type_{t-1}.Gsib$							-0.17
							(0.40)
$Const.$	-0.23	-0.12	0.07	-0.61	2.82	2.59	2.34
	(3.50)	(3.54)	(3.60)	(3.44)	(3.00)	(3.00)	(2.86)
Adjusted R^2	0.12	0.12	0.12	0.12	0.11	0.12	0.11
N	169	169	169	169	169	169	169
Sum interaction Comp.					-0.00	0.02	0.22
					(0.00)	(0.04)	(0.24)

Table 7: Bank cost of debt and complexity

$$CoD_{i,t} = \alpha + \beta_1\ Leverage_{i,t-1} + \beta_2\ Risk_{i,t-1} + \beta_3\ CapSurp_{i,t-1} + \beta_4\ Gsib_i + \beta_5\ Complex_{i,t-1} + \beta_6\ BankControls_{i,t-1} + FE_t + u_{i,t}$$

$$CoD_{i,t} = \alpha + \beta_1\ Leverage_{i,t-1} + \beta_2\ Risk_{i,t-1} + \beta_3\ CapSurp_{i,t-1} + \beta_4\ Gsib_i + \beta_5\ Complex_{i,t-1} + \beta_6\ (Complex_{i,t-1}.Gsib) + \beta_7\ BankControls_{i,t-1} + FE_t + u_{i,t}$$

Risk is defined as the RWA density. Data cover BHCs from 2010 to 2017. Standard errors are robust and control variables including dummies for FR and $Businessmodel$ are not reported in this table. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Leverage_{t-1}$	-2.36	-2.38	-2.37	-2.45	-2.44	-2.42	-2.54
	(1.53)	(1.55)	(1.54)	(1.57)	(1.60)	(1.58)	(1.61)
$Risk_{t-1}$	-19.44	-19.66	-19.28	-20.18	-21.01	-20.07	-22.64
	(27.33)	(27.52)	(27.37)	(27.70)	(28.63)	(27.79)	(28.60)
$CapSurp_{t-1}$	-1.69*	-1.69*	-1.70*	-1.72*	-1.70*	-1.71*	-1.74*
	(0.88)	(0.88)	(0.88)	(0.88)	(0.89)	(0.89)	(0.89)
$Gsib$	-5.16	5.28	8.70	29.08	-16.11	-6.88	-36.57
	(7.00)	(11.88)	(13.96)	(18.77)	(22.63)	(16.96)	(26.81)
$Total\_count_{t-1}$		-0.03			-0.06		
		(0.03)			(0.05)		
$Span\_c_{t-1}$			-0.34			-1.26	
			(0.32)			(0.99)	
$Span\_bus\_type_{t-1}$				-6.76*			-10.75*
				(3.59)			(5.56)
$Total\_count_{t-1}.Gsib$					0.07		
					(0.07)		
$Span\_c_{t-1}.Gsib$						1.17	
						(1.06)	
$Span\_bus\_type_{t-1}.Gsib$							10.27*
							(5.78)
$Const.$	178.27**	177.43**	176.78**	186.24**	199.58**	200.27**	218.44**
	(78.94)	(78.88)	(78.74)	(81.26)	(86.51)	(86.52)	(92.44)
Adjusted R^2	0.11	0.10	0.10	0.11	0.10	0.10	0.11
N	169	169	169	169	169	169	169
Sum interaction Comp.					0.01	-0.09	-0.47
					(0.04)	(0.31)	(2.06)

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